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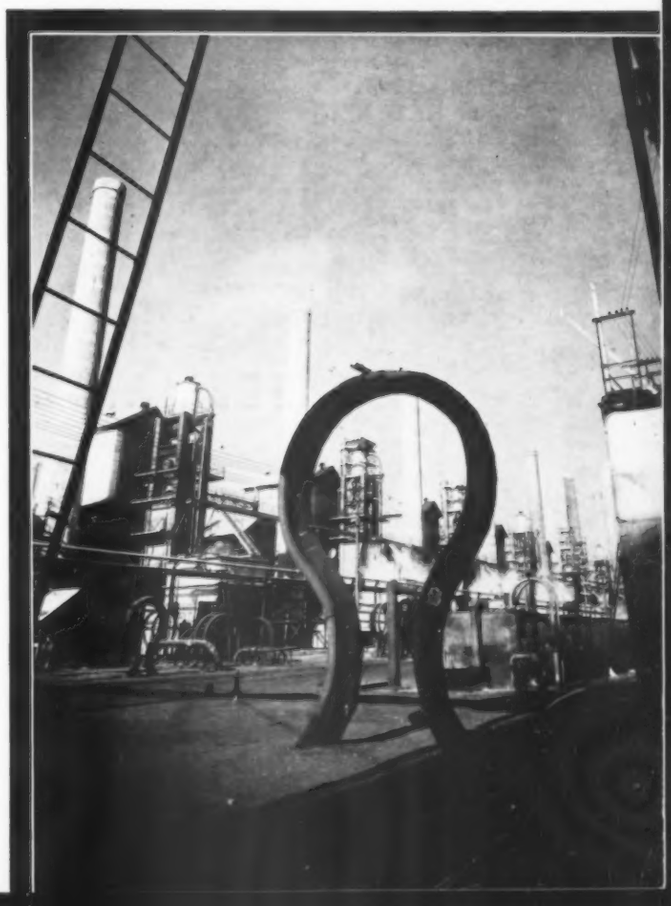
PETROLEUM

A Complete Account of Recent World Refinery Construction, Trends, Technical and Economic Progress • List of All Refineries Outside the United States • Technical and Economic Aspects of Catalytic and Thermal Polymerization • Possible Action in Washington Next Year Studied by Oil Men



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Bayonne, N. J.—One of the world's largest and most important refining centers, on the Atlantic coast of North America

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Refining Progress

REMARKABLE as has been the progress made in the refining art during the past quarter century it is no exaggeration to say that the problems before the petroleum technologist today are more numerous and in some respects more complex than those confronting him at the beginning of this period. The more chemists and engineers have learned about petroleum itself, the more they have taken it apart and studied its constituents, the greater have become the possibilities of new refinements and new applications, not only in the production of power and the elimination of friction but for many other purposes as well.

To one who follows the work of the men engaged in petroleum research it seems that the industry has before it possibilities of achievements greater than any it has attained heretofore. While the increased proportion of gasoline recovered from each barrel of crude during the past few years is looked upon as remarkable the experts tell us that further progress in this direction is still possible. New applications of heat, new chemical combinations, the use of catalysts and the accumulation of more complete scientific data regarding the structure and constituents of oil are leading the way to more efficient performance of the tasks that it is now doing and to the extension of its application to new and untried fields.

In the past petroleum technology has been occupied mainly with meeting the demands made upon it by users of the industry's products. The development of the internal combustion engine has called for continuous improvement and specialization in fuels and lubricants. The progress of aviation and the rapid rise of the Diesel have opened other new chapters. While still giving close attention to the problems presented to them from these quarters the leaders of research are now definitely entering upon other lines of experimentation suggested by their past experience and are leading the way not only in improving the yield and quality of main products but also in finding useful applications for the by-products and former wastes released in the processes of refining their crude material. Oil is today a most vital factor in industrial progress but its importance is steadily increasing and its ramifications into the fields of manufacture, transportation and all forms of power application are constantly extending. To the layman oil is oil but to the scientists who spend their lives in its study it is a bottomless well of possibilities from which they draw more and more useful discoveries the more they plumb its depths.

Economic Problems

NOT ONLY the technical but also the economic problems of refining have been multiplied. Nationalistic influences have led to the building up of the industry in places where it never before existed. Tariffs have closed long accustomed markets and fresh discoveries have called for the construction of expensive manufacturing facilities in new locations. On the one hand a multiplication of cheaply operated plants in centers of flush production has cut operating margins close to, or sometimes beyond, the vanishing point, while on the other hand politically favored commodities such as coal and alcohol have provided a subsidized competition in certain countries. Successful operation of a petroleum refinery today calls not only for a greater investment of capital and far more specialized equipment than in the past but also for a higher degree of technical ability and keener business acumen.

One of the complaints frequently voiced by members of the industry is the very rapidity of progress in manufacturing methods which makes constant change and replacement of equipment necessary. No sooner is one new process with its needful mechanical appliances in settled operation, they say, than some improvement is effected which makes a fresh installation necessary. There is more than a grain of truth in this statement and it frequently is a bit surprising to outsiders to hear refineries that are only from five to ten years old referred to as obsolescent.

In reality, however, the swift march of progress in machinery and methods is one of the great elements of strength to the refining industry. While it is true that there are many plants that have been rendered out of date by developments of the past few years and that a vast amount of reconstruction and replacement is needed the fact that more efficient and economical methods are constantly made available enables the progressive refiner to keep ahead of the procession and to command advantages of which the ruck of his competitors are slow to avail themselves.

Other pages of this issue present a record of refining progress during the past year and a discussion of some of the problems, both technical and economic, that are of particular interest at the moment to members of the refining industry. From a purely practical point of view perhaps the outstanding achievement of the oil industry, however, is the fact that exploration, investigation, research and experimentation have resulted in a continuous

cheapening as well as a steady improvement in petroleum products, thereby making them available to greater and greater numbers of the world's population.

▼

Ethiopian Mystery

PROMPT action by Messrs. Walden and Dundas of the Standard Vacuum Oil Company in placing before the State Department of the United States the facts in regard to the Ethiopian oil concession negotiated by Francis W. Rickett and equal promptness in stating to Secretary Hull their readiness to void the concession ended a four day sensation that echoed through the press of the world in the beginning of September. The mistake of Standard Vacuum officials was in permitting negotiations to go on after an acute political situation had developed, but their subsequent course unquestionably was the wise and public spirited one to take. While there is no reason to doubt their statement that the transaction was a development in the ordinary course of business as the result of negotiations begun months previously the manner in which announcement of this concession was put out in Addis Ababa made it evident that the Ethiopian ruler hoped or believed that it might in some way redound to the advantage of his people.

It has not yet been demonstrated that there is enough oil in Ethiopia to justify either a considerable investment of private capital in exploration or any loud sabre clanking by rival nations. In the inflamed state of feeling in Europe, however, the incident, which would have been of trivial interest at any other time, was in a fair way to create further complications in a situation already badly involved. Under the circumstances prompt withdrawal from the undertaking was an act of public service on the part of the oil company.

Suggestions that the granting of this concession might involve the United States in war never were anything but fantastic but the opportunity for press and politicians to treat it as though it contained such possibilities was too tempting to be resisted. Even high officials of the United States seem to have felt that the chance to claim a bit of political credit was not to be overlooked and sought to make it appear that they had forced relinquishment of the concession when as a matter of fact the action of Standard-Vacuum's officers was voluntarily taken. Some of the official utterances about dollar diplomacy may return in future to plague the Department of State.

▼

Political Encroachment

SOME remarks in this department last month on policies of the Roosevelt administration in regard to business in general and the oil industry in particular have met with a truly remarkable reception. They have been reproduced in leading newspapers and have brought us some hundreds of letters all of which (except one anonymous communication) have been commendatory of their general tone and the specific criticisms which they contained.

Since WORLD PETROLEUM can hardly be accused of political bias this response appears to us to indicate a widespread dissatisfaction with the effort to substitute governmental management for private enterprise in conducting the business activities of the American people and to replace with federal control state authority in regulating the internal affairs of the forty-eight members of the Union. The opposition is real and it cannot be quelled by sharp-tongued phrases. It is no answer to intelligent criticism of political banking to denounce those who utter it as minions of the money power nor can the support of any but the unthinking be gained for a discriminatory wealth sharing scheme of taxation by sneering at the "thrifty" element of the population.

There is a clear line of distinction between the *regulation* of business for the protection of the public interest and the interjection of government into the *management* of agricultural, manufacturing and commercial undertakings. This line has been overstepped by the whole group of measures proposed or supported by the national administration which were the subject of our previous comment. Some of them were subjected to modification in their course through Congress but their underlying tendency is clear to be seen.

The men who are alarmed by the legislation forced upon the country by President Roosevelt and his coterie are not minions of Wall Street. Wall Street in fact is anticipating a temporary harvest from the inflationist tendencies so strongly stimulated by recent federal acts and policies. Those who are most concerned are the men and women on the farms and in the industrial centres who are seeking to make a living by their own efforts and to provide employment that will encourage trade by the production of usable commodities as contrasted with the "made work" offered by the government as a thinly disguised dole. They are the savings bank depositors, the insurance policy holders and the millions of small investors in enterprises that will depreciate in value through a continuance of unbridled expenditure, unfair taxation and unsound finance.

One of the serious complaints voiced by people in all parts of the country regardless of political affiliation is that a system is being forced upon them which they have had no voice in choosing, which was never advocated in any party platform nor espoused before election by any successful candidate for high office. They view with distrust rising in many cases to indignation the absorption of power by the Executive no matter how attractive a personality may clothe the office at the moment.

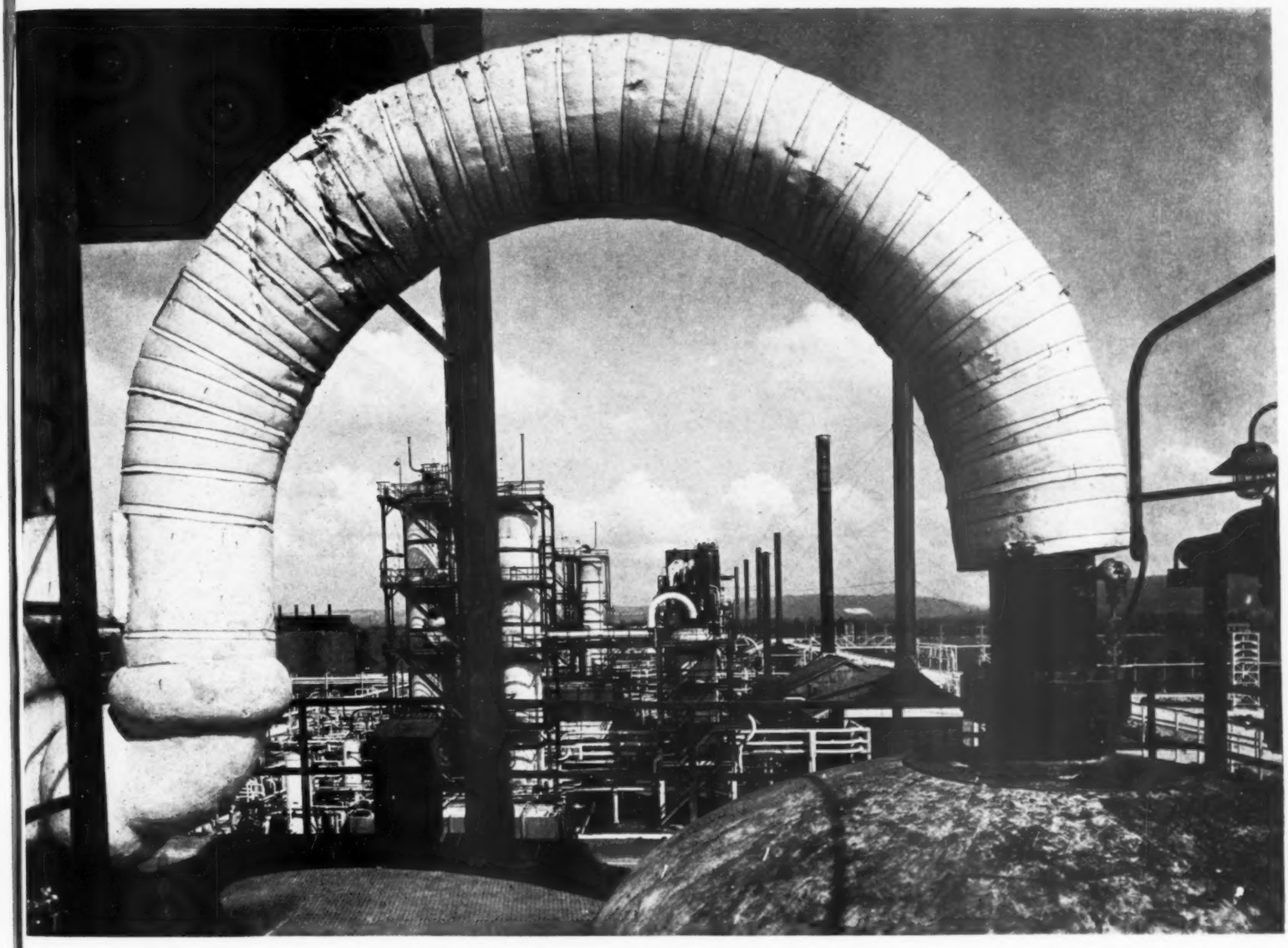
▼

New Policy in Mexico

AS A RULE governments do not take kindly to criticism of their policies, no matter how well intentioned or how constructive in character it may be. It is a pleasure, therefore, to record the very favorable reception given in official circles in Mexico to the article published by WORLD PETROLEUM in July in which it was suggested that the policy in relation to petroleum followed by that country for the past fifteen years had been detrimental to the welfare of the nation as a whole and had failed in its purpose of placing control of petroleum resources in the hands of native Mexicans. The article itself was widely quoted in the Mexican press with favorable editorial comment. It elicited approving letters from many individuals, including important officials, who expressed a desire to see the country's oil industry develop and resume something of its former position in the international petroleum market.

It is true, of course, that the obstructive laws and regulations which have hampered development were not the work of the present administration which, particularly since its recent reconstruction, has shown a genuine desire to encourage the oil industry without in any way sacrificing the national interests. Granting of drilling permits which had been suspended has been resumed and there is evidence of a willingness to place a definite interpretation upon existing laws and to adopt measures that will encourage the domestic demand for petroleum products and place producers in a better position to compete for international trade.

This can hardly be accomplished by government price fixing which so limits prices as to prevent improvement in the quality of products dispensed and in the service provided for consumers. More productive of results would be a reduction in the high retail tax of eight centavos per litre on gasoline and removal on the production and export imposts.



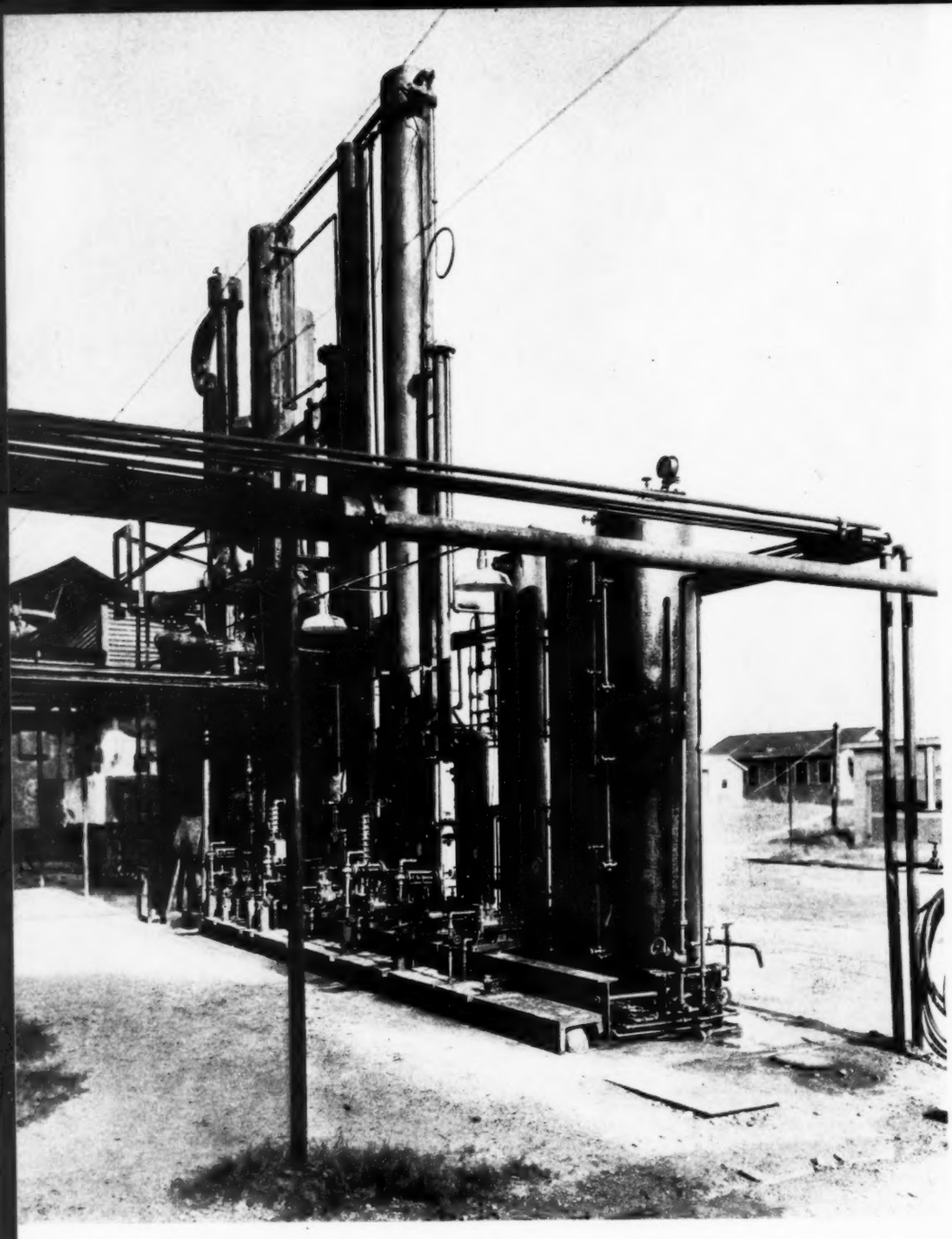
A striking view of one of the largest French refineries, Port Jerome plant of the Standard Franco Americaine de Raffinage.

Economic Analysis of Refining Trends

Economic Trends in Refining, Based on Data Supplied by G. R. Hopkins, Petroleum Economist, United States Bureau of Mines, to Don Kirkley, Washington Representative of World Petroleum

THE PETROLEUM industry in its extreme simplicity may be represented by the Indian who dipped up the iridescent scum from a body of water and rubbed it on his rheumatism. A slightly more complex phase would be the burning of petroleum at the well-head for whatever heat might be utilized. Thus, production, one of the major branches of the industry, might have had its primitive beginning. Possibly the production of this first well might have been carried a short distance and sold to a farmer as fuel. Thus two other major branches, transportation and marketing, would have been born. Refining, the only other major branch of the petroleum industry, represents one step forward from the primitive; its inception could have been actuated by the desire of the farmer to burn a more docile product. Although Nature has refined oil on a crude scale since nH's first met the required number of C's, man developed the art of refining only after experimentation showed that crude petroleum was worth more as products than as a complex mixture.

From its humble beginning, the art of refining has progressed to such an extent that crude oil can be fed in at one end of



Control unit charging five barrels per day, exactly reproducing the operation of the commercial size T.V.P. cracking unit.

a plant and literally hundreds of products drawn off at the other. Apparently an indispensable operation, but who can say that an engine will not be developed to burn crude oil efficiently leaving only the production of lubricants and some minor products to the refining industry. For that matter, having discovered "heavy" water, who knows but what "sticky" water will be developed to replace lubricating oils. However, at this time refining ranks as one of our leading industries and bids fair to hold that position for many years to come. It has been described as the bottle-neck of the petroleum industry, probably because there are only a few hundred refiners as compared with thousands of producers and marketers.

Integrated Companies vs. Independents

THE refining industry is not susceptible of easy economic analysis. The proposal to divorce or segregate the several branches of the petroleum industry would be beneficial in at least one particular—it would be easier to analyze conditions and prescribe remedies. At present, most of the refining is in the hands of the major or integrated companies, who control about 80 percent of the operating capacity. These companies supply some or all of their refinery requirements from their own production. The tendency is toward increasing the percentage of own production utilized, that is, for less oil to be purchased from independent producers. This trend would have been more pronounced if the forces of proration had not limited the output of the low-cost, flush fields for the benefit of the stripper areas. The best major illustration of such a condition is supplied by the East Texas field where sufficient oil to cover all U. S. refinery requirements could be produced at about 50 cents a barrel. Because of its high quality East Texas crude at 50 cents is preferable to other crudes at 40 cents. It is, therefore, not surprising that the integrated companies have increased their refinery runs of East Texas crude to a point where drafts on stocks are necessary. Exporting East Texas oil purchased at $1.00 for $1.25 and refining oil produced at 50 cents for distribution at the prices of the last two years has undoubtedly contributed to the improvement in financial statements. It is, therefore, not surprising that nearly all the favorable acreage in low-cost areas like the coastal district of Louisiana is controlled by the major companies. The sale of large groups of stripper, or high-cost, wells to independent operators within the last two years is substantiating evidence. Perhaps the majors will repurchase this acreage, regardless of the possibilities of deeper production.

The days of high refinery prices for gasoline, when independent refiners could pay almost anything for crude and still make a profit, appear to have gone forever. Likewise, the days of many and drastic changes in crude-oil prices appear to have passed into history. For the independent

Overhead ropeway for loading asphalt drums to vessels at the Fawley refinery of the AGWI Petroleum Corp. Ltd., in England.

A Universal polymerization plant processing 3,000,000 cu. ft. of cracked gas daily.

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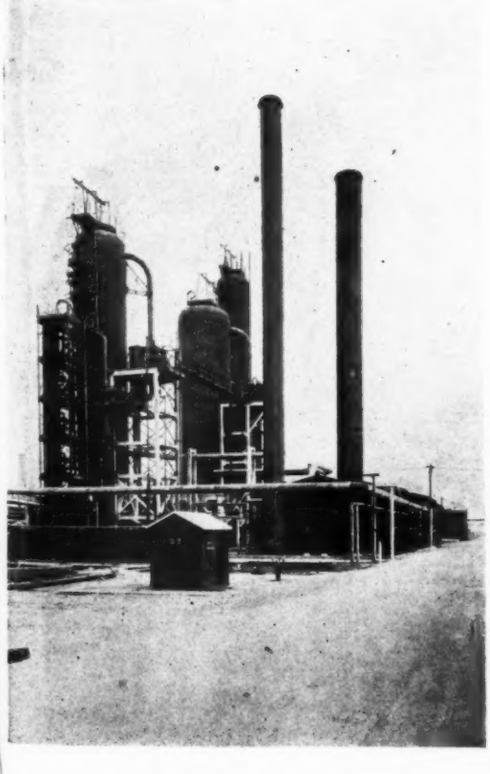
Distillation unit at the Richmond refinery of the Standard Oil Company of California.



refiner the matter of making a living has been simplified so that if he receives a refinery price for gasoline which approaches a certain percentage of the crude-oil price, and if he can dispose of his normal output, he makes a little money; otherwise, he loses plenty. This subject was studied at some length in the early part of this year by a Petroleum Code Survey Committee on Small Enterprise, which concluded in part:

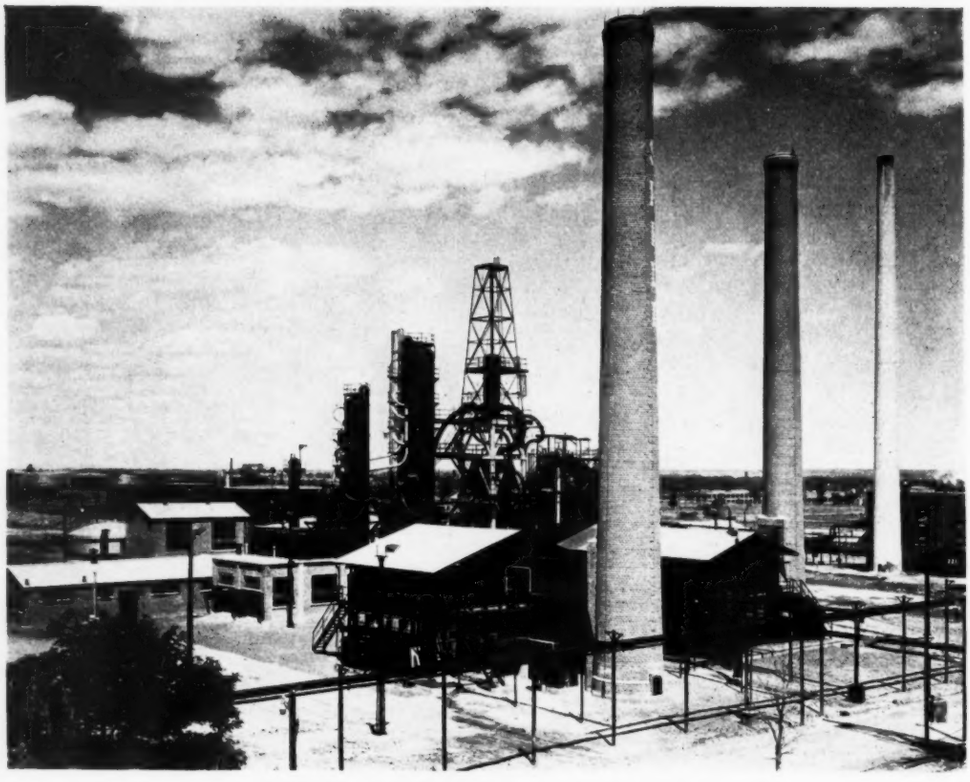
> We find that small, non-integrated refiners have been severely injured by the Code and are now (March, 1935) in an intolerable position because prices of crude oil and refined products are not on a parity. There are two ways by which such refiners can be relieved, namely, first, by an increase in the prices of refined products to a parity with posted crude oil prices; or second, by a reduction in crude oil prices to a parity with prices of refined products. The first alternative would relieve the refiners without injuring the producers and thus is preferable.

Nearly six months have passed since this statement was made and it is, therefore, appropriate to review developments in the light of possible progress or retrogression. The price of crude oil has not changed materially, except in California; hence it is only necessary to analyze the refinery price of gasoline. The price employed by the committee in its comparisons was that for Oklahoma f. o. b. Group 3, 63–70 octane. This price for February, 1935, the last month covered, was 4.39 cents per gallon. The monthly averages for the intervening period are indicated in the accompanying table.

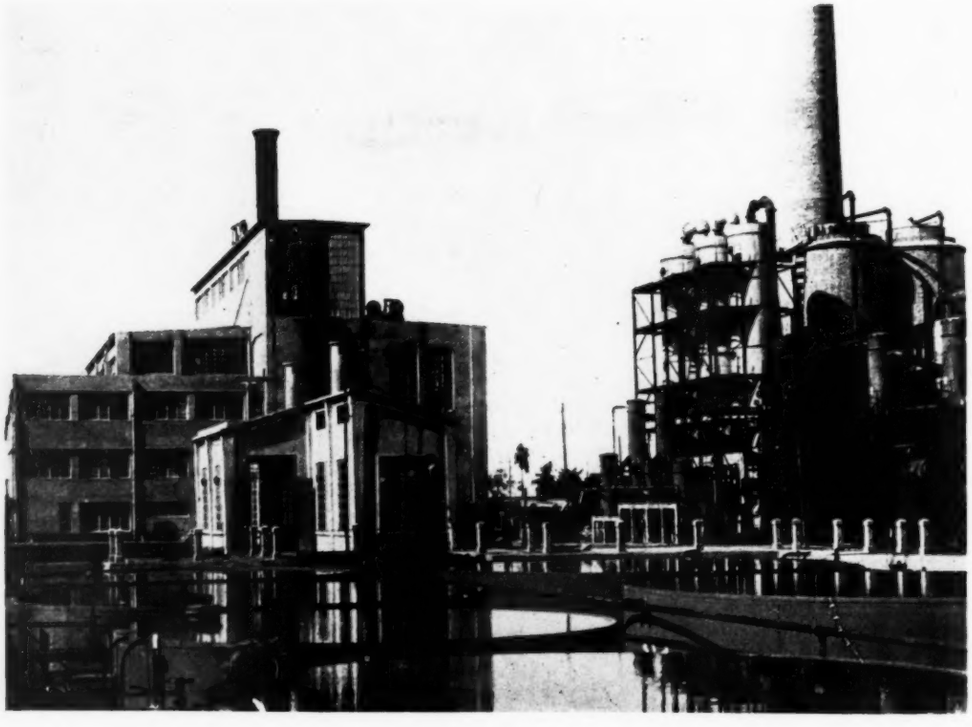
Monthly Average Price Group 3
63–70 Octane

1935	per gallon
March	4.75¢
April	5.18¢
May	5.41¢
June	5.68¢
July	5.69¢
August	5.69¢
September (1–16)	5.69¢

When the matter of price-fixing in the petroleum industry was a live subject in the latter part of 1933, it was determined that, in order for refiners to obtain a reasonable profit, the wholesale price of gasoline should be 6.00 cents per gallon when crude oil was $1.00. Assuming that half a cent per gallon on gasoline would constitute a reasonable profit, it is evident by inspecting the prices given above that the non-integrated plants are now netting about 40 percent as much profit as they should. Whatever the profit realized in the Mid-Continent in recent months, it has been sufficiently high to silence most of the clamor for a cut in crude oil prices.



Combination Dubbs two coil topping and cracking unit in Canada.



Kerosene plant at Batum, U.S.S.R. with an annual capacity of 30,000 tons.

What will happen when the demand for gasoline becomes less phenomenal is another matter.

Trends in Refinery Construction

UNTIL 1931 the capacity of the average refinery increased steadily; since 1931 there has been a distinct reversal in that trend. There were about 630 refineries as of January 1, 1935; these had a total daily crude-oil capacity of about 4,050,000 bbl. The average size was, therefore, about 6,500 bbl. On January 1, 1925, this average was about 5,300 bbl.; on January 1, 1931, it was about 9,000 bbl. These data should not be interpreted to mean that the large plants are growing smaller; in fact, most of the plants with a capacity above 25,000 bbl. daily are now larger than they were 10 years ago. The answer rests in the construction of about 75 relatively small plants in East Texas within the last four years and the addition of perhaps the same number of even smaller plants in other parts of Texas and in states like Montana, Wyoming, and Oklahoma. Most of the plants were constructed in East Texas in hopes of deriving profits from processing hot crude. The other group of small, scattered skimming plants was built to provide an outlet for crude or because some refiner was successful in raising the money for a fresh venture. The fact that practically all of the new plants were skimming plants does not mean that the trend is toward lower yields and reduced efficiency; it simply means that most of the newcomers could not afford expensive features like cracking plants and lube plants.

On January 1, 1925, the center of the active refining capacity was just northeast of Kingman, Kansas. Ten years later the center had moved southeasterly to near Noxie, Nowata County, Oklahoma. In the meantime the center of population was moving southwesterly through Indiana at a somewhat slower pace. This analysis apparently contradicts the generally accepted belief that the trend is toward the location of refineries near consuming centers rather than in the producing fields. However, the comparison simply indicates that new construction in East Texas and the Texas Gulf outweighs the increase in refining capacity in the populous central states. The expansion in the Gulf area is based on the desire of certain major companies to reduce transportation costs rather than on the development of new fields nearby.

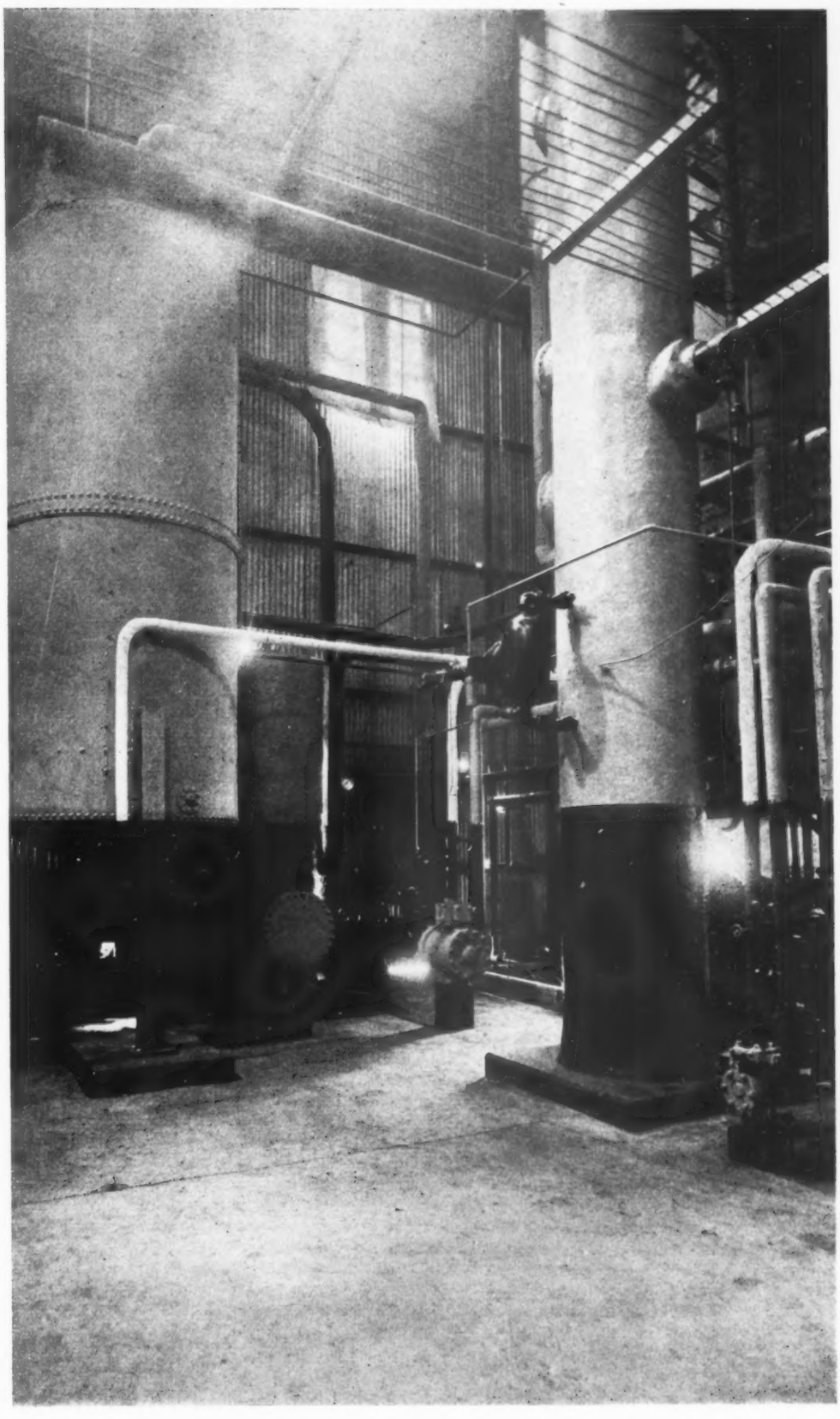
Another way of illustrating the shifts in refining centers is through a comparison of data on crude runs by districts. According to figures of the U. S. Bureau of Mines, crude runs to stills in the ten refinery districts have been as indicated in the accompanying table.

This table (p. 560) indicates centralization of refinery capacity in the populous Chicago area and in the growing Houston district. The gain recorded by the Texas Inland district reflects chiefly the construction in East Texas. The largest loser has been California, which has only stepped up its refinery operations by about five percent in 10 years as compared with an increase of about 40 percent for the country as a whole.

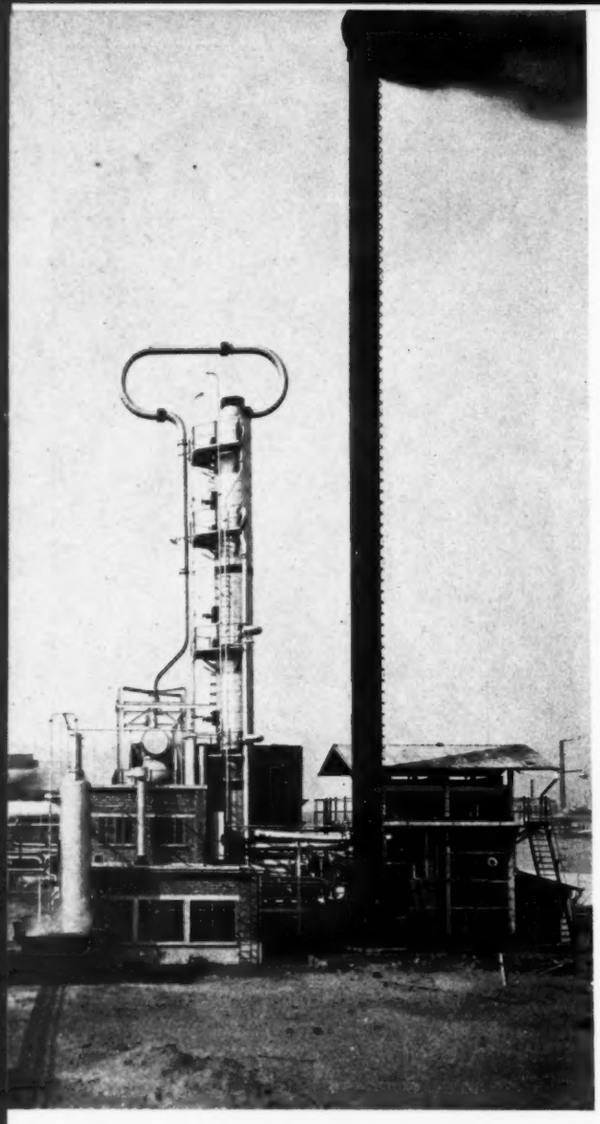
Shifts in Products

EVERYONE who is at all familiar with the early history of the refining industry knows that kerosene was the principal, generally the only refined product manufactured up to the beginning of this century. The gasoline fraction and generally the residual fuel oil were thrown away for want of a market. This condition lasted until the development of the internal combustion engine. However, the production of gasoline did not surpass that of kerosene until about 1915. The yield of kerosene declined steadily through 1931, after which successive gains were recorded in 1932, 1933, and 1934 commensurate with the increased demand for range oil. The yield of gasoline increased until 1933, when the first decline was registered. The decrease in gasoline yield in 1933 was 1.0 percent, or from 44.7 to 43.7 percent of the crude charged; the decline in 1934, while important, was only 0.3 percent. Until the last few years the trend in the yield of fuel oils was downward, as more and more of this class of oil was diverted for use as cracking stock. However, the material increase in production of the lighter-gravity fuel oils, gas oil and distillates, in 1934 was notable as indicating the gain in use of oil burners.

At the present time gasoline easily ranks as the most important refined product, but is its position impregnable? Will the relatively efficient Diesel engine supplant the notoriously wasteful gasoline engine? On the basis of simple economics, Diesel oil should have no difficulty in replacing gasoline as automotive fuel. It costs half as much and gives twice the mileage per gallon—a theoretical saving of 75 percent in fuel costs. This sounds fine, but it so happens that the cost of fuel is relatively less important than the cost of the car. The average motorist pays out only about $90 annually for gasoline. The intricate design of the Diesel fuel pumps, which must place a small drop of oil at exactly the right place at exactly the right time, and the lack of mass production, precludes the manufacture of a Diesel car for a price within possibly $500 of the cost of the average car. It would require several years to save that much on fuel. Furthermore, as recently pointed out by



Fractionation tower for extract in the chlorex plant of the Bradford-Penn Refining Company.



Foster Wheeler unit at the Redaventza refinery at Antwerp.

President Sloan of General Motors, Diesel oil would not escape state and federal taxes for long, so that the saving in fuel resulting from the difference between the per gallon cost of Diesel oil and gasoline would be wiped out. This would leave only the advantage of greater mileage to balance the higher initial cost of the car. However, this constitutes a real saving and the day of the Diesel automobile may not be as far away as generally predicted. Although a recent press notice states that only 900 Diesel trucks and busses are on the roads, Diesel-powered tractors, particularly the heavy-duty type, are growing rapidly in favor.

Conservation

THE REFINING industry has contributed heavily toward conserving our limited supply of petroleum. In the first place, it has developed the cracking process to a point where nearly as much gasoline is made by that method as by skimming. In other words, almost twice as much crude oil would have to be processed if we were forced to depend on the equipment of 10 or 15 years ago.

As indicated above, conservation through the increased use of Diesel oil is slow in coming. However, the refiner should not be blamed in that connection as it is his job to make the products demanded by consumers. If the Diesel car appears en masse, it will be because the public thinks it is a better automobile rather than because the refiner has grown tired of making gasoline. The refiner can set the style in equipment and methods but not in products.

Another conservation angle that is not as creditable to the refiner concerns the yield of gasoline in the last three years. Although it is possible to obtain up to 75 percent gasoline recovery from crude, with 60 percent as a goal, the industry is now getting a bare 45 percent. Apparently it has no intention of obtaining the additional 15 percent, as the yields of 1935 have been less than in 1933 and 1934. The most common excuse for the low yields of recent years has been that the plants in East Texas recover only 35 percent of gasoline, which reduces the national average by several tenths of one percent. The failure to come even close to the 60 percent is explained by saying that this would require all refineries to have cracking plants, a financial impossibility. Maybe so, but it is probably a fact that many plants could step up their yields 10 percent more without overtaxing their equipment. Some might claim that the refining industry can only dispose of, as gasoline, 45 percent of the crude they have to buy from producers. Undoubtedly many refiners do not attempt to obtain the maximum yield of gasoline, preferring to sell part of what could be used as cracking stock as fuel oil or road oil. This supplies an argument for those who contend that we should turn some fuel oil markets over to coal or to imported oil. Assuming that all the skimming plants were granted loans to build cracking units—not so absurd these days—and the yield of gasoline were stepped up to 60 percent, refinery requirements for crude oil would be reduced by about 250,000,000 bbl. This would constitute real conservation to most everybody except possibly the producers.

With and Without the Code

THE REFINERS took an active part in drafting the code in the summer of 1933 but when things got going in October they found the producers and marketers had stolen the show. Perhaps there were some missing paragraphs, but apparently in the excitement of trying to find a word meaning "mandatory" in federal dictionaries and "recommendatory" to the states, the refining industry was virtually forgotten. Article IV of the original code had a paragraph or two about the "proper relationship between inventories of gasoline and sales thereof" and committees were established to "call the attention of refiners within their respective districts to the existing and recommended ratios between gasoline inventories and sales." Some of the ratios were established but it is doubtful if more than a handful of refiners conformed to them. It did not take long to ascertain that the refinery control provisions of the code were quite devoid of results so that Article IV was rewritten in the spring of 1934. As redrafted, the article provided for regimentation without compulsion. The part played by the federal government, the determination of proper inventory and production levels for gasoline for the country as a whole, was simple, yet important. It was the function of the Planning and Coordination Committee to divide the national totals equitably among the companies. This was done through a system of committees and sub-committees which were so all-inclusive that few companies were outside the fold. The oil industry learned long ago that recalcitrants can be quieted more quickly in committee rooms than on the field of battle. Protests against the allocator's orders were considered by a Board of Review.

Crude Runs to Stills

District	1924 Thousands of barrels	1924 Percent of U. S. total	1934 Thousands of barrels	1934 Percent of U. S. total	Change in percent
East coast	135,202	21.0	171,733	19.2	−1.8
Appalachian	21,958	3.4	35,809	4.0	+ .6
Indiana, Illinois, etc.	56,399	8.8	119,166	13.3	+4.5
Oklahoma, Kansas, etc.	79,701	12.4	95,006	10.6	−1.8
Texas Inland	30,992	4.8	61,941	6.9	+2.1
Texas Gulf	94,033	14.6	179,418	20.0	+5.4
Louisiana Gulf	36,754	5.7	41,341	4.6	−1.1
Arkansas and La. Inland	12,663	2.0	18,850	2.1	+ .1
Rocky Mountain	26,737	4.1	16,037	1.8	−2.3
California	149,280	23.2	156,335	17.5	−5.7
U. S. Total	643,719	100.0	895,636	100.0	.....

Aerofilms

East Ham refinery in England belonging to the Red Line Glico Company.

The system became operative about June, 1934; by the time the code was invalidated, nearly a year later, it was hitting on at least 7 out of 8. Actual gasoline production was generally higher than the total determined by the Federal Agency but toward the last the excess did not amount to more than 2 or 3 percent. The lack of adequate data on working stocks of gasoline was at first a handicap in determining the proper economic levels of inventories, but this situation improved in the early part of 1935, after a special inventory committee made its report.

The success of the refinery control features of the amended code bears out the contention of those who have maintained that the place to stabilize the industry is at the "bottle-neck", the refineries. Without the backing of laws such as those regulating production, the refining industry, by sheer cooperation, was able to clean house and start the heavy consuming season of 1935 on a sound basis. In running at only a few percent above the quotas, the refiners helped to keep crude-oil production in conformity with the allocations.

Following the invalidation of the code, crude runs to stills rose materially, with the gain more pronounced than could be justified by a normal seasonal increase. To illustrate, reports of the American Petroleum Institute show daily average crude runs for the weeks just prior to and after the invalidation as shown in the accompanying table.

Some refiners increased their runs for legitimate reasons, others to steal their neighbors' business, but most just to make sure they wouldn't be caught short of gasoline. Fortunately for all, the increase in gasoline consumption in July and August exceeded the most optimistic expectations and even the worst offenders have been able to dispose of their production.

Crude Runs to Stills Before and After Invalidation of the Code

1935		barrels
May	4	2,415,000
"	11	2,520,000
"	18	2,530,000
"	25	2,685,000
June	1	2,625,000
"	8	2,510,000
"	15	2,690,000
"	22	2,755,000
"	29	2,750,000

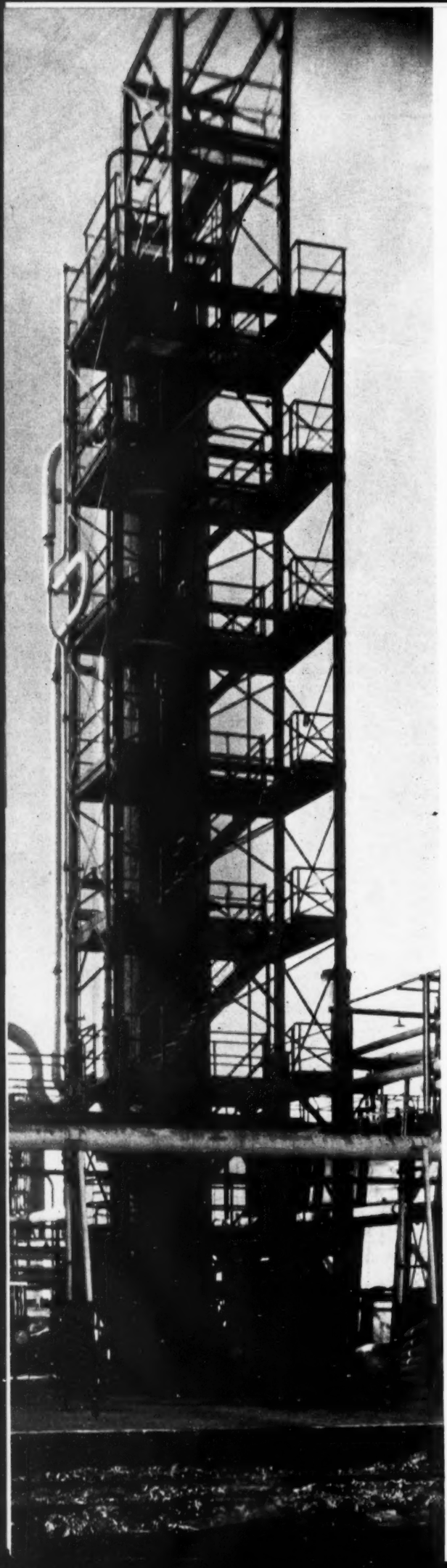
The dire predictions as to prices and wages after the invalidation have not been fulfilled. As a matter of fact, refinery prices of gasoline in Group 3, the generally accepted standards, increased in the last few days of May and the first few days of June, and have retained those gains since that time. Likewise, the course of average hourly wages has been upward since the invalidation. According to the Bureau of Labor Statistics, the average increased about two percent between May and August, 1935, reflecting the increases made by a few major companies about June 1. Some of the small independent refiners have undoubtedly lowered their scales, which, with the higher gasoline prices, probably accounts for their silence of the last few months.

Technical Developments

ALTHOUGH the pipe still is without doubt a more efficient piece of apparatus than the old shell still, there are still hundreds of the latter in use. Shell stills are being replaced by pipe stills and shell stills and obsolete cracking units by combination units, but the changes are unhurried, even in cases where the companies have abundant capital. Although the total crude-oil capacity of the pipe stills increased 2.5 percent in 1934, or from a total of about 2,950,000 bbl. on January 1, 1934, to about 3,025,000 bbl. on January 1, 1935, the total capacity of the active shell stills is approximately 1,600,000 bbl. Likewise with cracking equipment, the obsolete units are being replaced by new ones, but the new ones are not so superior to the old types as to cause a wholesale modernization. Combination units which skim and crack and handle all the crude processed in the plant are the latest thing in distillation equipment but the chances are they will be obsolete long before they will have found universal application.

The development of the solvent method of lubricating-oil manufacture has received wide attention during the last three years. In brief, the method embodies selective extraction of the desirable elements by the use of solvents. The solvents vary with the particular process, propane, benzol, phenol, and chlorex, an ether, being the most common. The solvent method can also be used for dewaxing, but so far there has been no material replacement of the filters and centrifuges commonly used in wax removal.

The present production of solvent oils in this country is estimated at around 15,000 bbl. daily or the equivalent of about 20 percent of the total. Solvent oils are acknowledged to have a superior viscosity index, that is, they stand up better, deposit less carbon, and show a greater resistance to sludging. Unfortunately, the line of demarcation between a good motor oil and a poor one is not clear to the average motorist, or for that matter, to lubricating technicians. The motorist knows



Fractionating tower in a modern American refinery.

a poor motor fuel by the sound, but an inferior motor oil carries on its insidious work in silence, at least in the good cars. The trend toward the use of the lighter oils required by the new cars has favored the growth of solvent refining; however, there are still literally millions of motorists that think they must use an oil with the consistency of cold molasses, at least in summer.

The development of solvent refining and the parallel increase in use of light oils has had a marked influence on refinery operations, particularly in districts like the Appalachian, where lubricating oil is the primary product. Some of the refiners in that area were apprehensive as to whether their products would continue to command premium prices; likewise, the producers of Pennsylvania Grade crude oil were concerned as to whether their oil would continue to be priced at double the Mid-Continent quotation. Most of the pessimism was unjustified as the solvent process cannot perform the miracle of making good lubes out of poor crude, yet the recent declines in the Pennsylvania Grade prices may have been based on more than overproduction and increases in crude stocks. Certainly the trend toward the use of lighter oils has forced the Pennsylvania refiner to increase his output of neutrals and reduce his production of heavy, bright stocks. Light cracking of heavy lube stocks in the production of neutrals is becoming common practice.

The manufacture of lubricating oils by hydrogenation has proceeded simultaneously with the development of solvent refining. The claims for hydrogenated oils are much the same as for solvent oils, that is, high viscosity index and low carbon deposition. However, hydrogenation costs are reported to be much higher, which has proved a deterrent to expansion.

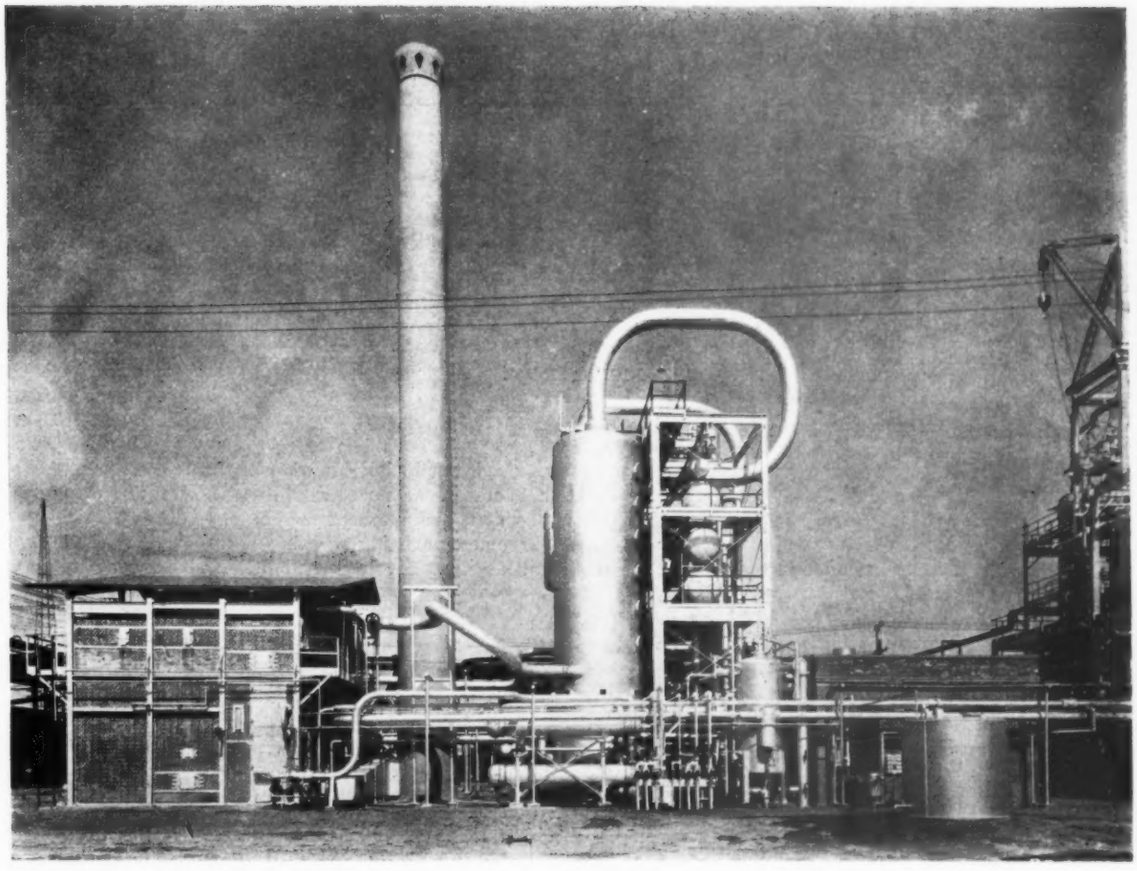
Gas polymerization is the latest development in refinery technology to receive widespread attention. A recent newspaper article describes the pooling of patents by a group of major companies. The process covers the production of high-octane motor fuel from refinery gas. Economically, the development of polymerization means the ultimate recovery of perhaps 20,000,000 bbl. of high grade blending material annually. Progress in the refinery industry is well illustrated by the changing role of refinery gas—first it was thrown away, then most of it was recovered for direct use as refinery fuel, later most of it was treated for absorption gasoline and the residue used as fuel, now it is used in the manufacture of 100 octane gasoline, the highest quality motor fuel.

Developments in Refining Outside U. S.

PARALLEL with the growth in world production of mineral oils, many new refineries were built in other countries in the first six months of 1935, and many old refineries were enlarged or modernized. The increase in refining capacity was most marked in the Union of Soviet Socialist Republics and in Roumania, where domestic production and domestic demand are both expanding. In the Soviet Union the total annual refining capacity increased from 187,000,000 bbl. in 1932 to 193,000,000 bbl. in 1935. The increase was chiefly in cracking capacity, which rose from 21,000,000 bbl. in 1932 to 30,000,000 bbl. in 1935. With the increased industrialization of industry and increased mechanization of agriculture in the Soviet Union, there has been a shift in the emphasis of demand from kerosene and fuel oil to gasoline. Accordingly, the second 5-year plan calls for an increase in cracking capacity from 30,000,000 bbl. in 1935 to 47,000,000 bbl. in 1937, as well as an increase in straight-run capacity from 163,000,000 bbl. in 1935 to 192,000,000 bbl. in 1937. The 1935 program includes the completion of four cracking plants at Saratov; four at Grozny; four at Baku; one at Khabarovsk in eastern Siberia; and one at Yaroslavl, as well as four pipe stills at Baku, one distillation plant at Yaroslavl, and one pipe still at Orsk.

Refining operations in the seven months of 1935 realized only 87 percent of the activity scheduled by the second 5-year plan. With an annual quota of 162,000,000 bbl. for 1935, Soviet refineries ran to stills from January to July 81,000,000 bbl. of crude petroleum, compared with 84,000,000 bbl. in the first seven months of 1934. This decline was due to the failure of the Baku field to yield its scheduled quota of crude petroleum. A vigorous drilling program and a more decentralized plan of administration have been adopted to increase the production of crude both in old and in new fields.

In Roumania a 73-percent increase in the production of crude petroleum between 1929 and 1934 was paralleled by a 75-percent increase in refining capacity during the same period. The increase in refinery capacity has resulted from the enlargement or modernization of existing plants and the addition of cracking equipment. Few new refineries were built, chiefly because of the lack of available capital and from the effects of the economic depression. In the first six months of 1935 Roumanian refineries ran to stills



A modern Gyro vapor phase refinery

28,115,000 bbl. of crude, a decrease of 3.5 percent from the 29,234,000 bbl. run to stills in the first six months of 1934.

In France the rapid increase in refinery capacity registered from 1929 to 1934 continued into 1935. French refineries delivered to consumers 18,620,000 bbl. of refined products from January to July, 1935, compared with 14,373,000 bbl. in the first seven months of 1934. At the same time imports of refined petroleum products into France decreased from 8,356,000 bbl. in the first seven months of 1934 to 4,948,000 bbl. in the corresponding months of 1935. The French refining capacity was increased by the opening in April of the complete modern refinery of the Pechelbronn Ouest Co. at Donges, near St. Nazaire, with almost entirely French-built equipment. By the end of 1935 the Compagnie Française de Raffinage is scheduled to have in operation a new 9,500-bbl. refinery at Martigues, on the Etang de Berre, near Marseilles. This refinery, built to treat crude from Iraq, will include crude distillation, cracking, and stabilizing units.

Petroleum refining in Italy continued in 1935 the decline begun in 1934. In the first five months of 1935 Italian refineries turned out 823,000 bbl. of refined petroleum products, compared with 1,102,000 bbl. in the same period of 1934. On the other hand, imports of refined petroleum products into Italy increased 23 percent, or from 1,205,000 bbl. in the first five months of 1934 to 1,484,000 bbl. in the corresponding period of 1935.

Present Statistical Position

FOR THE last three months the production of crude has exceeded the recommendations of the Bureau of Mines by approximately four percent. However, no particular harm has resulted to the statistical position of crude as the demand has broken all records, at times being well above the 3,000,000 bbl. mark, and crude stocks have been consistently reduced. Likewise, the demand for gasoline has exceeded expectations; the total demand (domestic demand plus export) in July, 1935, was 13 percent above July, 1934, and August of this year may have improved on that performance. The result has been that, regardless of what the refiners have done in the way of running crude or making gasoline, stocks of gasoline have been reduced faster than contemplated and refinery prices have been maintained at relatively high levels.

Although the demand for gasoline over the last quarter of 1935 will probably eclipse the record of 1934, a sharp seasonal cutback will be necessary to prevent too rapid increases in stocks, distress gasoline, and much lower prices. Refiners should plan to reduce their daily runs progressively by six percent in October from September, two percent more in November, and three percent more in December to maintain the present strong position.

East Texas with its hot oil, was about the only source of worry until Rodessa and the California price cut came along. East Texas is pretty much an old story now as the industry has become accustomed to absorbing the 50,000 bbl. more or less, of hot oil. The Rodessa threat hasn't appeared so menacing since the oil was analyzed and found wanting in octane, and since the second well hit salt water. California continues to produce 100,000 bbl. a day more than is necessary but probably none of the excess will ever appear on the Atlantic seaboard. Now if the Railroad Commission of Texas should destroy another open pit, if the sovereign State of Louisiana should join the compact, if production in California is curtailed, if Rodessa flops, if crude runs are reduced, the industry should start the new year in a healthy and favorable position. Otherwise, the industry might be afflicted with that dread disease known as chaos.

Technical Problems in Petroleum Refining

Present Trends in Refinery Practice Give Indications of the Directions in Which Higher Efficiencies Are Likely to Be Obtained—Neglected Products Call for Closer Study.

CONSTRUCTION of a crude distillation unit with a capacity of 65,000 bbl. per day indicates the confidence in present engineering data to cope with the problems involved in the production of products now required. Existing units have been designed largely from empirical data gained by operating experience, and while no doubt such data will continue to be of importance in the design of units for fractions currently produced, the substantial contributions recently made to development of a sound theoretical basis for petroleum fractionating equipment and better knowledge of the functioning of such fractionating equipment may lead to important further improvements. Methods now employed in the vacuum distillation of lubricating cuts do not give the closest fractionation possible and further investigations in this field may lead to improvement in yields of present products or development of products with more desirable properties.

The isolation of high octane cuts from a low octane gasoline, and investigation of the ultimate chemical constitution of the gasoline fractions undoubtedly will stimulate activity in this direction. The Podbielniak centrifuge separator and contactor is revolutionary in principle and gives promise of making possible the production of cuts having properties of unusual interest and value.

In view of the fact that from a large percentage of crude only gasoline, kerosene and fuel oil is produced it is rather surprising that there has not been a greater use of combination units in order to utilize the waste heat available in cracking. The successful operation of several combination units of very large capacity indicates that anticipated economies have been realized, particularly in view of the fact that some of the more recent installations of this type have been for the purpose of replacing existing cracking equipment rather than for increased output.

PARADOXICAL though it may seem it is nevertheless true that the rapid progress in petroleum refining during the past few years leaves the research men of the industry today with more problems confronting them than at any time before. As more knowledge has been gained of the product itself and of its chemical constituents more possibilities have been opened of modifying and combining these to produce final products adapted to highly specialized uses. In the following article attention is drawn to some of the unanswered questions before investigators and an indication is given of the directions in which further research is likely to lead to important practical results. The author, who is one of the foremost authorities in his field, unfortunately insists on remaining behind the cloak of anonymity. This does not detract from the value of his article though addition of his signature would give it immediate authority.

As a result of more detailed investigations and more experience gained in operating existing cracking equipment substantial economies have been made, but such economies have resulted from better control, elimination of troublesome coke deposition, more complete protection against corrosion and similar improvements which make possible longer runs, better heat economy, and larger throughput.

It would appear that the possibilities of temperature and pressure as a means of improving gasoline yields from cracking have been rather well explored. The effect of very short time contact at much higher temperatures is an interesting field of investigation. While only a comparatively small amount of data has been reported, using laboratory cracking apparatus, such data as are available give encouragement to the view that by such methods our knowledge of the limits of conventional cracking processes can be rather expeditiously established. From a comparison of the carbon to hydrogen ratios of gasoline and cracking stocks it has long been evident that much higher gasoline yields are theoretically possible. In order to effect the basic change in the cracking reaction necessary for a material suppression of gas and coke formation it appears that recourse must be had to the use of catalysts and from the number of patents of this nature being issued it is apparent that considerable study is being given to this possibility.

Utilization of hydrogenation for production of motor gasoline from petroleum fractions is dependent upon the difference in the price of crude and fuel oil. A recent critical study of the problem indicates that with differentials even now current, hydrogenation justifies some consideration. The most promising application is in connection with or as an adjunct to cracking, since the best return by hydrogenation is by use of a feed stock to the hydrogenation unit which gives a low yield by cracking, as for instance a heavy gravity, comparatively low boiling cycle gas oil, which is a very refractory cracking stock. This would emphasize the importance of studying cracking from the standpoint of the elimination of the conventional method of recycling with the fresh feed and utilizing instead successive stage cracking of cycle gas oils separately to permit elimination of the most refractory and least desirable cracking stocks for hydrogenation. There is the possibility, however, that such materials may find an outlet as furnace oils, with a better return than is possible by hydrogenation, which again emphasizes the dependence of hydrogenation on fuel prices.

Any possible shortage of petroleum in the apparently distant future will force

an increase in fuel oil prices, which will be checked by increasing utilization of coal. Thus, the increase in fuel oil prices will be relatively less than in crude in which case hydrogenation will be effective in the conservation of petroleum resources. With continuation of present prices it is apparent that the heavy investment for hydrogenation cannot be justified without marked reduction in operating costs, which, in turn, seems to depend on cheaper methods for producing hydrogen, such for instance as obtaining hydrogen as a by-product of some other operation.

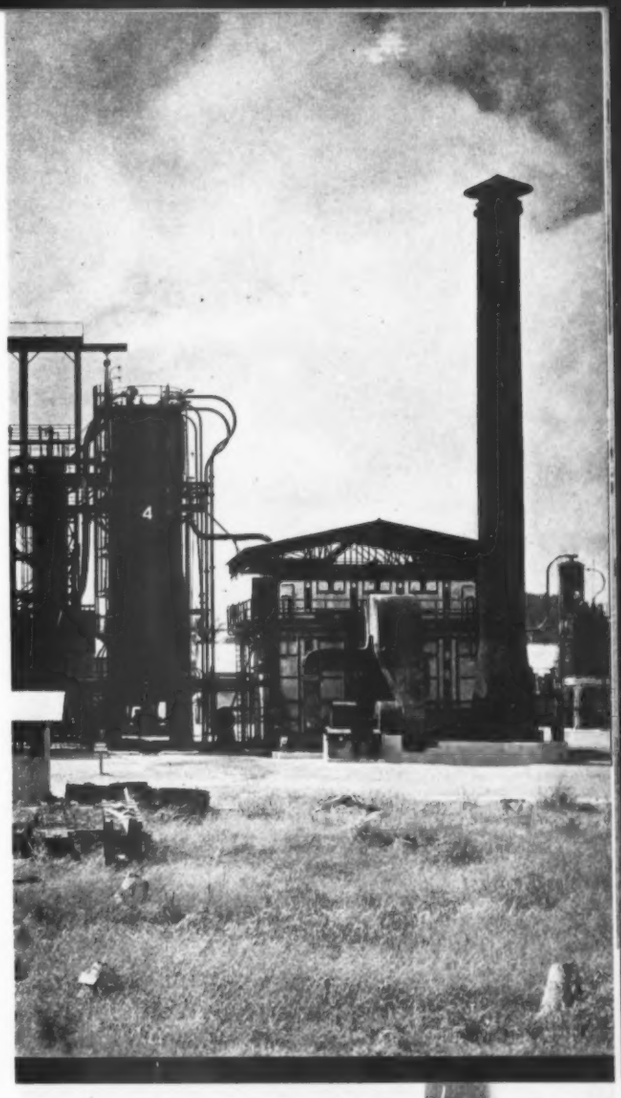
The advent of gasoline anti-oxidants has made somewhat uncertain the fate of conventional methods of treatment of cracked naphthas. While no data are at hand showing the quantity of chemicals being consumed as gasoline anti-oxidants, references are available indicating that this development has made unnecessary acid treatment and rerunning of many cracked naphthas for production of gasolines stable in storage, with resultant large economies. Where acid treatment of cracked naphthas is being employed for sulfur reduction, active consideration is being given to a counter-current treatment with sulfuric at low temperatures in a multi-stage quick contact operation, followed by centrifugal separation. Justification for this process would imply acceptance of a maximum limit for sulfur in gasoline, which is a problem still unsettled to the satisfaction of all concerned. A number of novel processes of sweetening gasolines have been proposed, but it is apparent that "doctor" treatment seems to continue as the mainstay, and is even more firmly entrenched as a result of improvements in the speed of revivification by better contact with air and better recovery of naphtha from the spent doctor by centrifuging.

The possibilities of solvents for extracting the more valuable fractions have been considered as evidenced by patents issued. The solvents mentioned, however, are those which would be expected to separate the aromatic and possibly naphthenic materials which have not the anti-detonating value of iso-paraffins. It has been suggested that recourse be had to extremely low temperatures, with the thought that crystallization may be a means of separating the branched chain paraffins which are of greatest value in gasolines. It is apparent that analytical methods for quantitative determination of the branched paraffins present in gasolines have not been successfully developed.

Predictions of the manufacture of synthetic organic chemicals using petroleum products as a source material have been realized much sooner and on a scale greater than the most optimistic could have hoped. While this must be regarded as an outstanding achievement it is apparent that operations of this character will be limited by market demand. Of importance is the recent initiation of plant scale operations producing gasoline, by polymerization of the unsaturates present in cracked refinery gases, by a process employing a "solid phosphoric acid" catalyst, which is said to be capable of indefinite regeneration. By this process it is possible to produce a minimum of 3½ gallons of high octane gasoline per 1,000 cu. ft. average cracked refinery gas, and it is said to be capable of producing 1,000,000 bbl. of gasoline per year. A recycling process of the "heat and pressure" type for production of gasoline by polymerization of cracked refinery gases containing a high percentage of olefins has been in plant scale operation for some time. It is apparent that from different cracking processes gases of different olefin content may be expected and it will be of interest to see if these polymerization processes can be applied with advantage to all cracking operations and if cracking processes will be modified as a result of the advent of polymerization.

More recently fundamental experimental data on the high pressure pyrolysis of the gaseous paraffin hydrocarbons have been published, which show that very attractive gasoline yields can be obtained by pyrolysis of these materials in a recycling operation, employing heat and pressure. The successful operation of this type of process on plant scale recently has been announced. It naturally follows that this type of operation, on account of its much greater possible yield, will be competitive with the catalytic polymerization of cracked refinery gas. These developments obviously point to the fact that considerably more data and analysis will be required fully to establish the advantages of the various possible methods or possibly combinations of processes which will produce the best return.

There is an urgent demand for aviation gasoline with an octane value equal to or closely approaching that of iso-octane itself, and the fact that such materials have been supplied in rather limited commercial quantities presages important



Above: Part of a Dubbs cracking unit in Trinidad, B.W.I.

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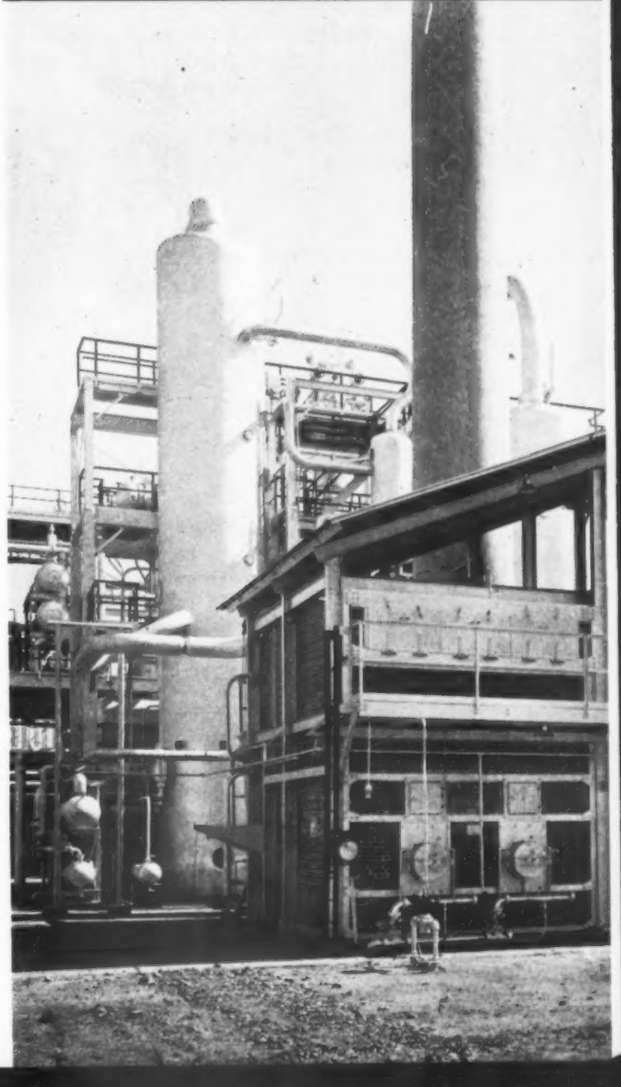


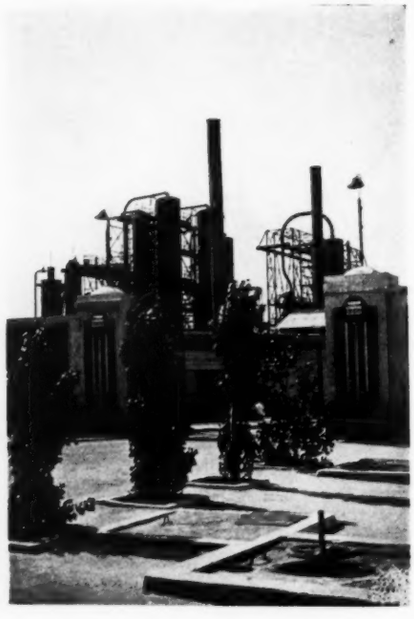
A vapor phase cracking unit in the United States.

developments in this direction. By polymerization of isobutylene to di-isobutylene and hydrogenation of the latter, a product has been manufactured which approaches iso-octane in anti-knock value and lead response. It would seem that, if necessary, butane or other products may be added for the desired volatility. It is known that cracked refinery gases contain appreciable quantities of isobutylene and it would be expected that this would be examined first as to its possibility of being an adequate supply, but undoubtedly thought will be given to additional sources, possibly in a more available form. Recent experiments have shown methods by which aromatics may be alkylated. Patents have been issued in which claims are made that olefins may be made to react with hexanes for production of branched chain materials of high anti-knock value. Undoubtedly such possibilities as the two last mentioned will receive increasing attention in the production of synthetic gasoline of unusual properties.

The trend toward uniformity of octane number of gasoline continues, as a result of the fact that a very large part of the present gasoline production contains sufficient tetraethyl lead to increase its octane to the definite maximum standard provided for the so-called leaded "Q" gasoline. An appreciable percentage of the regular grade gasoline is maintained at 70 octane number without the use of lead, but it would appear that in general the industry finds it more economical to use lead than resort to drastic cracking and reforming of straight run gasoline in order to meet this octane requirement. It has been estimated that approximately 10 percent of the straight run gasoline being produced is now being reformed. While possibly this is being done chiefly for improvement of octane number the operation is employed in some cases for improvement of volatility. The very marked trend during recent years toward more volatile gasoline, which is apparently still uninterrupted, has been marked by much greater lowering of 50 and 90 percent evaporated temperatures than the reduction of the 10 percent point evaporated temperature. Even here, however, the change has been considerable.

A corner of the yard of the naphtha refinery at Baku, U.S.S.R.

Sovfoto



Notwithstanding the large amount of apparently thorough and comprehensive work being done on standardization of methods of testing the anti-knock value of gasolines, it is still evident that the current ASTM Method does not correlate with road service tests for all gasolines in all makes of cars.

In view of the large sums spent for tetraethyl lead, and in view of the widely recognized fact that there is an enormous difference in the response of various gasolines to tetraethyl lead, it is rather singular that more research has not been devoted to the causes of these differences in lead response. A limited amount of data has been published on the effect of various sulfur compounds on lead requirements, but insufficient data are available to permit of satisfactory conclusions regarding the desirability of treatment for removal of specific sulfur compounds. That differences in the lead response of blends can-

Llandarcy, Wales, refinery of the National Oil Refineries, subsidiary of the Anglo-Iranian Oil Company, Ltd.

not be attributable solely to the effect of sulfur is evident from the very comprehensive investigations of the lead response of various pure hydrocarbons, and obvious from other observations. It would seem that lead cost could be reduced materially by further investigation into the fundamental phenomena involved.

Notwithstanding the fact that the comparatively recent employment of the centrifuge in the sulfuric acid treatment of lubricating stocks has made possible substantial improvements it seems conclusive that this time-honored method is rapidly becoming obsolete due chiefly to its inability to produce lubricating oils having the desired temperature viscosity relationships and superior resistance to oxidation.

The present widespread and increasing utilization of solvent refining has made available a wide range of crudes as a source of lubricating oils having desirable properties some of which were obtainable only from certain crudes of limited production and availability. An enumeration of the many solvents and combinations of solvents that have been proposed would be tedious. A considerable number of solvents are in commercial use in the several processes regarding which rather complete data have been reported giving the results of plant scale operations. It is apparent that the various methods have their advantages when limited to definite application. From these data it

should be possible to develop satisfactory information on the comparative advantages and limitations of the various solvents for specific uses.

The laboratory methods which have been elaborated for determining the yields of lubricating oils of any desired properties from a particular source should be of great utility. These same methods will be used for testing the solvent refined products from which conclusions should be possible as to the degree of attainment of the ideal sought. This should furnish a means of comparing the efficacy of the various solvents and methods of solvent refining, thus establishing their relative advantages for particular applications. Counter-current contacting the solvents with the lubricating stock and subsequent separation of the raffinate and extract mixture from the solvents, a step common to all processes, is being further investigated with no clearly established conclusions as to the advantages of packed towers or the various mixing and settling devices, both of which are in use for this purpose. Separation of the solvent from the raffinate and extract is effected by distillation which involves problems peculiar to the solvent employed. In the beginning it seems that the value of solvent refining of lubricating oils was stressed chiefly from the standpoint of obtaining a decreased tendency toward change of viscosity with temperature. The yield is decreased as the viscosity index of the product is increased and from many crudes the yield of very high viscosity index material is quite small. The degree of refinement justified is determined by many factors including yield and quality desired and availability of various crudes, all of which must be evaluated for satisfactory economic comparison. Considerations of this nature have led to the development of materials which, even though added in relatively minute quantities, have a decided effect on the viscosity-temperature relationships. Whether or not any deleterious effects result from the use of such dopes must be established by service tests.

The quality of the lubricant should be judged principally by its ability to reduce wear and lack of suitable methods for correlating wear with the properties of the oil, as determined by routine laboratory tests, has hampered progress in the production of oils with outstanding quality in this respect. Recently, data have been published on the determination of wear in automobile motors as affected by the material which can be separated by solvent refining. While there is lack of satisfactory agreement as to conclusions drawn it is apparent that this is largely due to lack of suitable methods for determining wear. Considerable data have been reported on development of a laboratory method for determination of relative resistance to oxidation of lubricating oils presenting evidence of the superiority in this respect of solvent refined oils. These indications have been confirmed by service tests but more data will be required to gain general acceptance of the methods of tests and any conclusions that may be drawn. The increase in octane number of the gasoline required to eliminate detonation caused by carbon deposition has been the object of some investigation with some indication that by actual service test this important quality of motor oils can be determined. By continued investigations of this nature it should be possible to develop information to show the desirability of having good oxidation resistance and low carbon forming tendencies to prevent the necessity for octane increase in the fuel.

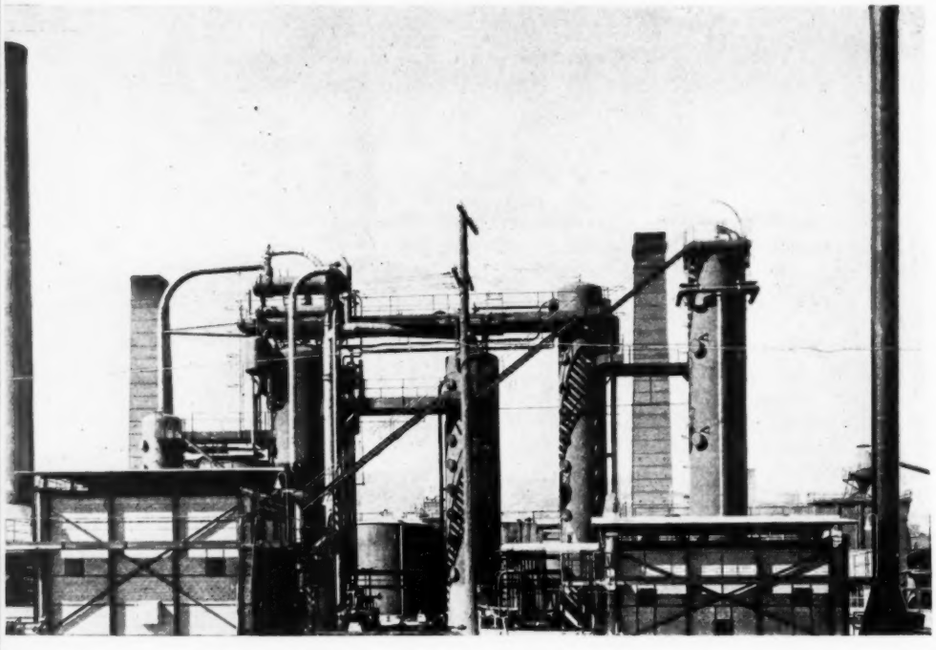
By way of summary it is apparent that further elaboration of quantitative service testing will be necessary to delineate the properties of superior motor oils and that when such quantitative data are available the efficacy of the various refining operations can be properly evaluated and modified to produce the materials required.

Propane is a solvent useful not only in the production of lubricating oils with the desirable properties discussed above, but following such use it can be evaporated and thus by self refrigeration low temperatures are made possible for dewaxing. Notwithstanding the present commercial utilization of these and other unique properties of propanes other dewaxing solvents are extensively employed. Among the latter may be mentioned acetone-benzol which is probably the first dewaxing solvent to be used commercially. In a later installation acetone-benzol-toluol is employed and in a still more recent installation a mixture of methyl-ethyl ketone and benzol is the preferred dewaxing solvent. Various chlorinated hydrocarbons have been proposed as dewaxing solvents and some are in commercial use in a centrifuge process in which the wax is removed from the central portion of the centrifuge bowl of special construction.

Solvent dewaxing is applicable both to residuums and distillates of high and

low wax contents. The important advantage resides in the fact that with these newer methods dewaxing can be accomplished with a much smaller differential between dewaxing temperature and the desired pour point than is possible with the conventional dewaxing processes; therefore the economies in operation are of considerable magnitude. It is for these reasons rather than for any outstanding improvement in quality that they would be expected to displace in the near future low temperature centrifuging of residuums in naphtha solution and the much older filter pressing of chilled distillates.

Little information is available regarding the quality of the wax obtainable with these new dewaxing processes nor of the methods which will be used for refining these waxes to meet present wax requirements. Presumably this is due to wax being regarded as a by-product. It is apparent that wax deserves and will receive more attention from the standpoint of cheaper processes to supply present demands, as well as research into utilization of its unique properties for new uses and as a source material for the synthesis of new products.



Phenol treating plant at the Richmond refinery of the Standard Oil Company of California.

Encouraging progress in the solution of the problem of better adaptation of compression-ignition engines and their fuels to each other has been made by the extensive cooperative work toward this end by the petroleum industry and Diesel engine manufacturers. The ideal fuel is one characterized by good ignition quality with a minimum viscosity, which requirement can be met by straight-run gas oils with considerable expense in order to meet the necessary low pour. No data, however, have been reported on the most suitable dewaxing processes available nor the probable cost of obtaining the requisite low pour. The possibilities of pour depressants in order to insure pumpability have not been given in detail. All of these desirable characteristics are reported as being incorporated in a gas oil which is produced as a by-product in the once-through hydrogenation of refractory gas oils from which gasoline is the principal product. Even with such a product it would seem that it would command a relatively high price since it undoubtedly will produce high gasoline yields when used as a cracking stock. The consumer expects a low price for such fuels and this constitutes the major objection to straight run Diesel fuels as they are valuable for gasoline production. Cracked gas oils, on account of their lower value for gasoline production, should be available at a lower price, but when compared to straight run products the cracked gas oils have poorer ignition qualities. This limitation could be obviated by use of dopes, the use of which in Diesel fuel will insure satisfactory ignition. There are objections to the various dopes which have been proposed but the development of a dope which will prove satisfactory will receive continued investigation. While the development of a satisfactory dope may render cracked gas oils satisfactory from the standpoint of ignition utilization of these products may be contingent upon the ability to produce from these sources material of satisfactory viscosity if a minimum volatility requirement is imposed, as has been indicated by some recent disclosures. At least such a requirement would reduce the quantity of material available.

Only gasoline and heavy industrial fuel oils exceed in volume the distillate now being used as domestic furnace oil, the consumption of which is increasing faster than any other petroleum product, at a rate which has led some to predict that within approximately five years furnace oil production will exceed that of gasoline itself. In view of the foregoing it appears rather singular that so few data have been published regarding the qualities which are necessary for these domestic furnace oils and how the demands for these distillates can be supplied most logically.

While possibly quantitative data are not available there is ample evidence that heavy gravity cracked fuel oils will constitute a constantly increasing percentage of the fuel oil for industrial and marine usage and that eventually cracked fuel oils will be used almost exclusively for such purposes. Due to their heavier gravity cracked fuel oils furnish a greater number of heat units per unit of volume and due to their usually much lower viscosity, much less heating is required for pumping and atomization. These advantages have been recently recounted and undoubtedly there is a growing appreciation among users. Obstacles have been met in the utilization of heavy cracked fuel oils due chiefly to deposits in tankage and heaters and unsatisfactory combustion with consequent formation of carbon deposit on burner tips and furnaces as well as excessive smoke and ejection of stack solids. Where these fuel oils are furnished with a viscosity somewhat lower than the average, in order that minimum heating is required for proper atomization, the deposits in heaters and tanks have not been troublesome.

While large quantities of these fuels having a gravity heavier than water are being satisfactorily consumed, there is still a demand for gravities sufficiently lighter than water to permit drawing water from the bottom of tanks. It would seem that the available future supply of industrial fuel oils will depend on the success of coking operations more than any other one process. A number of plants combining coking with cracking have been developed and are in commercial use. It is apparent that these processes are utilized to best advantage where the demand for

industrial fuel oil is so limited as to make prices unattractive. No data have been reported which give adequate information for comparison of the economies of cracking and combined cracking and coking.

No pronounced changes in the manufacture of asphalt have taken place recently, but the gradual reduction in volume of imported, highly asphaltic crudes has been made possible partially by the increased use of vacuum distillation equipment on crudes not adaptable for asphalt manufacture in older types of equipment. Several vacuum units have been placed in operation specifically for the purpose of asphalt manufacture from domestic crude. Only crudes yielding asphaltic residues reasonably free from paraffin are suitable for this purpose.

The increasing use of selective solvents for lubricating oil manufacture is resulting in the production of extracts many of which offer possibilities for use in asphalt manufacture. The greatest difficulty in the way of utilizing these extracts for this purpose lies in the fact that the products are extremely susceptible to temperature changes. Methods of overcoming this defect are needed before these extracts can be satisfactorily utilized for asphalt. The use of selective solvents on residua offers distinct possibilities of producing satisfactory asphalt stocks from residua not otherwise suitable. Several patents have been issued on the utilization of solvent extracts of various types in asphalt manufacture and it is reasonable to assume that commercial procedures will be developed.

A pronounced increase in the use of liquid asphaltic products on secondary roads has taken place in recent years. These products are asphalts cut back with a naphtha distillate or emulsified with water. Their increasing popularity depends upon the fact that they may be applied without the use of heat. Special equipment has been developed for producing these materials. Various types of emulsifying machines are now in use with a large number of emulsifiers, some of which are produced from petroleum sources. These emulsifiers are usually either soap of one kind or another or clay. On account of the specialized nature of these products and the cost of transporting water a large portion of the emulsions being manufactured are made locally near the point of application, the refineries merely supplying the asphalt.

Cracked residua are being used for liquid asphaltic road materials rather extensively. The future use of these materials will perhaps depend not only upon service results obtained but upon the price obtainable in relation to fuel oil and non-cracked residua. For low cost roads these products appear to be quite satisfactory if used correctly. They are frequently superior to poor grades of non-cracked asphaltic materials. A wide difference in quality is obtainable from various cracking stocks and equipment, but it is not reasonable to expect cracking developments to be affected by the quality of residue on account of its low price.

In the manufacture of air-blown asphalts continuous methods have received considerable attention and several patents have been issued. Various mechanical means of accelerating this reaction have been tried, but most such processes necessarily involve the removal of excess heat produced by the reaction. The additional equipment and expense is not always justified and, for this reason, relatively few installations have been made. As older types of stills are worn out it is probable that installations involving the use of mechanical agitation, very probably in vertical rather than horizontal units, will be installed.

Sovfoto

One of the laboratories of the oil institute at Moscow.

Studying Ignition Quality of Diesel Fuel

RECOGNITION of the importance of producing Diesel fuels possessing certain essential characteristics has necessitated the introduction of special methods of fuel testing in order to enable phenomena occurring in spaces of time as short as one ten thousandth of a second to be accurately observed. At the Shipping, Engineering and Machinery Exhibition, held in London during the latter part of September, the Sunbury Electrical Indicator, designed and developed in the Research Laboratory of the Anglo-Iranian Oil Company Ltd., was on exhibition to the public for the first time. Phenomena in the C. F. R. engine to which it was coupled could be observed through the medium of a cathode ray oscillograph. Explanations were given by attendant scientists.

The essential characteristics of a good Diesel fuel may be grouped under three headings; (1) Suitable physical characteristics, (2) Correct ignition quality, and (3) Freedom from contamination. Of these three, ignition quality is the most elusive and difficult to check because it cannot be determined by any known laboratory test, but can only be satisfactorily examined by taking careful records of the behavior of the fuel in the engine itself. The Sunbury Electrical Indicator is in regular use for investigating problems such as these in connection with fuel research and engine design.

World's Refineries Show Constant Growth

Notable Increases In Number, Size and Efficiency During Past Year—Spread of Cracking and Solvent Treating Plants a Feature of Current Progress.

EXTENSION of plant facilities through additions to capacity and installation of specialized units has been the noteworthy feature of refinery construction during the past year. Spread of the demand for cracking equipment has led to the creation of cracking plants even in refineries of relatively small capacity which would not have considered such equipment a few years ago. Progress in the cracking art also has brought about the revamping of many existing units.

Distillation, stabilization and vapor recovery units have been included in new plants constructed and have been added to many others erected in previous years. Recognition of the value of solvent treating processes in the production of lubricating oils has resulted in special activity in the building of solvent treating and dewaxing plants. Polymerization is the latest development to enlist the interest of refinery organizations and numerous installations of polymerization units are under way or planned.

While there has been much commiseration with the small refiner and much talk of his being thrown out of business it is worth noting that, in the United States especially, the greater part of the construction activity during the past year has been in the building of relatively small plants. It has been discovered that the difficulties of the smaller refineries were due primarily, not to their size but to their poor equipment. With the provision of improved manufacturing facilities refineries of 1000 bbl. capacity or less are demonstrating their ability to meet competition from the larger plants and enjoy certain advantages in serving their immediate territory. Michigan, Texas and California have been centers of activity in the construction of moderate sized refineries.

Oil companies operating on the Pacific Coast of the United States have carried out very extensive programs of expansion and new construction, including not only refinery work but also the building of additional pipe lines and terminals. Standard Oil Company of California late in 1934 adopted plans for major construction at its Richmond refinery and has translated these plans into concrete achievement during 1935. The principal additions included a combination atmospheric and vacuum crude unit, a solvent treating and recovery plant and a lubricating vacuum rerun unit which, together with improvements in crude receiving facilities, involved an expenditure of roundly $2,250,000.

The combination two-stage distillation unit has a charging capacity of 21,000 bbl. of crude per day. The crude is fed through appropriate heat exchangers and a tubular heater to a fractionating column which is 13 ft. in diameter and 101 ft. 6 in. in height. From appropriate points in the tower well fractionated cuts may be withdrawn ranging from light gasoline to light lubricating oil distillate. From the bottom of the tower a heavy residuum is withdrawn to be fed through a second tubular heater to the vacuum column which is 19 ft. 6 in. in diameter and 64 ft. 2 in. in height. From this fractionating column a number of closely fractionated lubricating oil distillates can be withdrawn. From the bottom of the column residual oil is discharged, ranging in penetration from 30 to 60. To a large extent the unit is equipped with electric prime movers. Control is centralized and automatic equipment has been provided to assume a close regulation of quality. The unit was constructed by the M. W. Kellogg Company.

A wide range of lubricating oil distillates produced on the combination unit can be handled by the solvent treating and recovery plant, the rated charging capacity of which is 3,580 bbl. per day. The feed stock contacts the solvent (phenol) at the proper temperature and the raffinate and extract are withdrawn continuously for further processing. Both of these products pass separately through individual recovery systems where the phenol is removed and returned for further use. The separate systems consist essentially of heat exchangers, vacuum and atmospheric towers, tubular heating furnaces, condensers, coolers and accessory equipment. As in the case of the combination unit, electric motors are largely used as prime movers and a considerable amount of automatic equipment with centralized control has been provided. The plant was built by the Fluor Construction Company.

The lubricating oil vacuum rerun unit was constructed for the final fractionating of the distillates after their treatment in the solvent plant. The oil is fed through appropriate exchangers to a tubular heater, thence to a fractionating column which is 13 ft. 6 in. in diameter by 64 ft. 2 in. in height. From this column a number of cuts meeting desired tests may be simultaneously withdrawn. As in the case of the crude unit, this installation is equipped with electric motors and automatic control. It was constructed by the M. W. Kellogg Company. The rated charging capacity is 3,450 bbl. per day.

At its El Segundo refinery near Los Angeles, Standard Oil Company of California has enlarged its facilities for receiving and discharging oil, has improved the distillation facilities and electrified its pumping plant and other refinery equipment.

As part of its extensive expansion work in which some $8,000,000 is being spent Associated Oil Company is making important additions to its Avon, California, refinery. These include a rerun unit for the lubricating oil plant, a butane recovery unit and a stabilizer and fractionator unit. The latter is being constructed by the Braun Corporation and in connection with this work the stills from which cuts to be handled by the unit are drawn have been overhauled and put into first class condition.

An addition to the first run unit to increase lubricating oil and asphalt production has been made by E. B. Badger & Sons and the same firm has reconstructed the rerun unit of the lubricating oil plant by installation of a pipe heater and vacuum tower with a capacity of 2,000 bbl. per day.

Gironde Refinery (The Texas Corporation) at Bec d'Aruber.

The butane recovery unit built by Alco Products Inc. will handle the higher factions produced by previously existing units.

At Martinez, California, Alco Products Inc. designed and constructed for the Shell Oil Company in 1934 pressure distillate, recovery and stabilization units with a capacity of 12,000 bbl. daily of pressure distillate and 500,000 cu. ft. of gas. To these has been added this year a fractionating unit to produce liquid propane from a light cracked gasoline cut. The gasoline is fed to an ethane tower when the methane and ethane are removed. The remaining propane and heavier elements are fed to a second tower when the propane is fractionated and condensed as an overhead product. Approximately 40,000 gallons of propane per day are produced in this manner.

The important propane solvent plant of the Union Oil Company at Oleum, California, devoted to the production of the company's special brand of lubricating oil was described in the October 1934 number of WORLD PETROLEUM as most of the construction work was done during that year.

An addition to the refining facilities of Southern California is the plant of the Wilshire Oil Company at Santa Fe Springs. It includes a Dubbs unit designed to top 12,000 bbl. per day of crude oil and to crack 8,000 bbl. of the topped crude. The plant was designed and constructed by the Ralph M. Parsons Co. Its equipment includes a light oil furnace, heavy oil furnace, reaction chamber, flash chamber, primary and secondary fractionating columns, residue flash column, distillate stripper, absorber, stabilizer, heat exchangers, light and heavy steam devices, hot oil pumps, direct action pumps, recording and control instruments and the usual range of accessories.

The construction is of alloy steel throughout. All vessels are fusion-welded, stress relieved and built in accordance with the latest designs.

The steam generating equipment consists of four 520-h.p., 500 lb. boilers delivering steam to turbo pumping equipment from which the exhaust at 150 lbs. pressure will be utilized in the operation of the other refinery units.

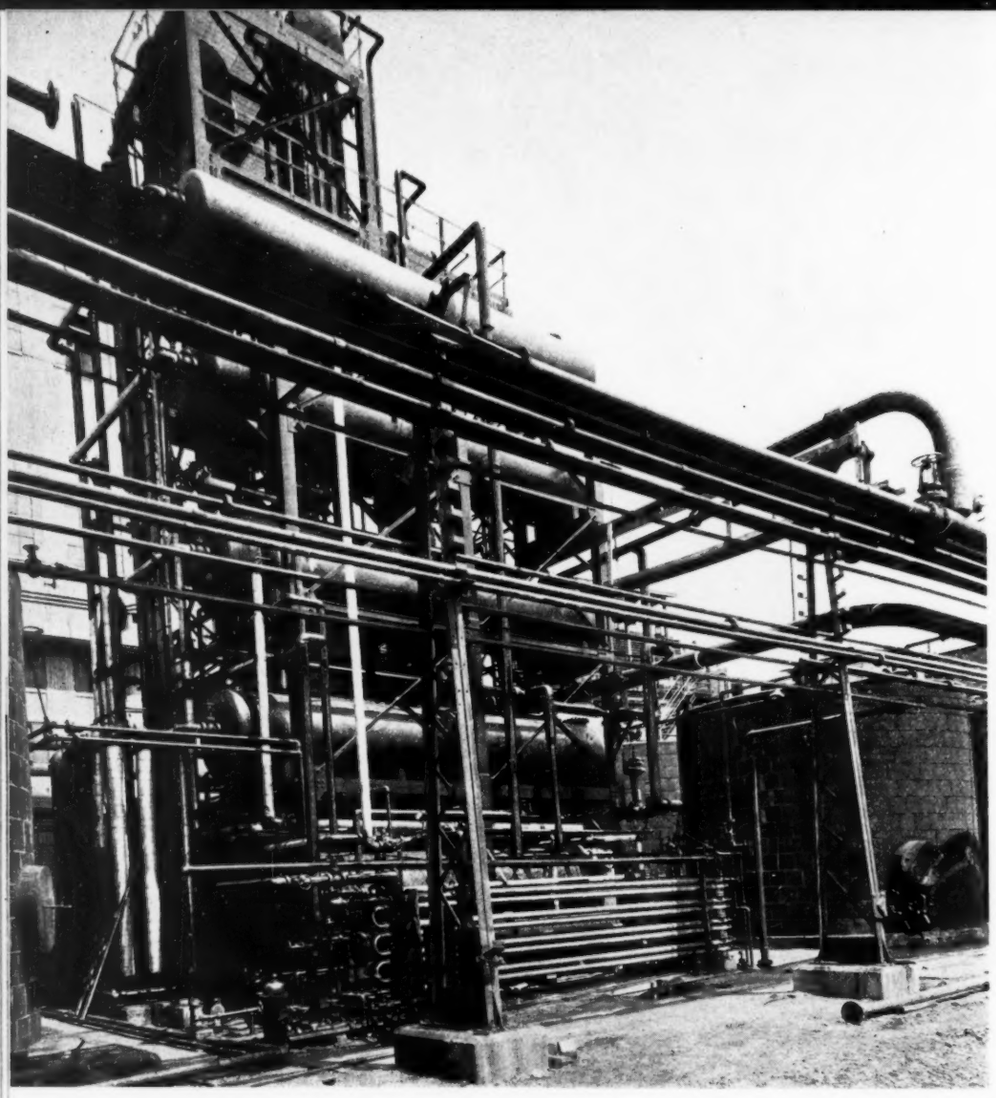
A water cooling tower approximately 1,000 ft. long will be installed. This will have a capacity for cooling 12,000 gallons of water per minute. A modern transfer pumping station is provided with engine driven pumps to transfer oil from the Santa Fe Springs refinery to the main storage tanks at Vernon.

In conjunction with the transfer pump equipment there will be a complete system for acid-treating of pressure distillate, redistilling and subsequent doctor treating. This equipment includes centrifuges, settling tanks, rerun column, heat exchangers, special rerun furnace, doctor treating tanks and other units.

The run-down tankage consists of eighteen 5,000 bbl. steel tanks, all of welded construction. These will be encased in a concrete dike approximately eight ft. high. A centralized foam fire-fighting installation is being put in.

The refinery will have a complete machine shop. A large laboratory is being installed with complete testing equipment for control of refinery operations. There are three water wells equipped with deep well pumps continually discharging into a 200,000 bbl. concrete lined earthen reservoir. There are the usual auxiliary buildings with steel frames and sheet steel walls. A large pipe rack is provided with facilities for proper maintenance and repairs. The boilers will be equipped with economizers, forced draft fans and short stacks.

An interesting new California installation is the cracking unit of the Rice Ranch Oil Company at Santa Maria which employs the Lincoln Clark vapor phase process.



Freedom solvent extraction unit constructed by Leader Industries.

A special feature of this plant is the burning of fuel under pressure in a chamber with no heat removal devices so that combustion gases may be mixed directly with vaporized gas oil to heat it to cracking temperature. The simplicity of the plant reduces mechanical and labor costs and permits very economical operation. The Lachman process for treatment with zinc chloride is included in this plant which has a daily capacity of 500 bbl.

At Fruitvale, California, Mohawk Petroleum Company has added to its 5000 bbl. skimming plant a unit of 1500 bbl. capacity designed especially for the production of road oils.

Two projects announced recently are those of the Stockton Oil Company for a cracking plant and vapor phase unit at Stockton, California, and the Airlane Refining and Transport Company's proposal for a vapor phase refining and cracking plant of 100,000 bbl. capacity at the same place, together with a pipe line from Kettelman Hills to serve it with crude.

Development of production in the Rocky Mountain section has led to new construction activity in that area. Home Oil & Refining Co. of Great Falls, Montana, has remodeled its plant under the direction of Ralph M. Parsons Co. and has installed a Parsons-designed Dubbs two-coil selective cracking unit of 500 bbl. capacity. Included in this are special fractionating columns, day treating plant and a polymerization system together with two specially designed cracking furnaces.

The continuous treating and redistillation plant consists of tile-lined treating vessels, fractionating column, heat exchangers, condenser, double-duty furnace, pumps and other miscellaneous items. A complete absorption and stabilizing unit containing an absorption column, stabilizer column, heat exchangers, condensers and accessories is included in the plant as is also an asphalt unit. In addition to the refining units proper two 250 H. P. water tube boilers were installed.

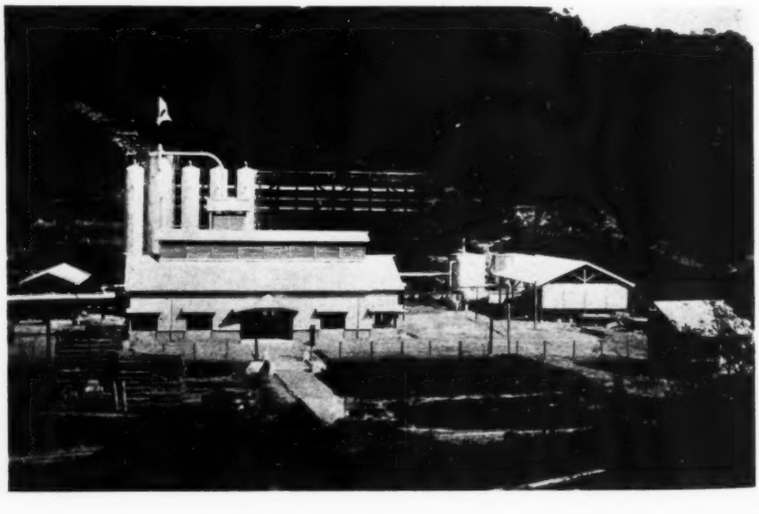
The Big West Oil Co. at Kevin, Montana, has installed a complete tail gas and gasoline stabilizing unit to operate in connection with a 1000 bbl. Dubbs cracking unit. The installation was made by the Ralph M. Parsons Company. The refinery reports a three percent increase in gasoline yield and a one and two point gain in octane rating from these new facilities.

The International Oil Co., subsidiary of The Texas Company, has modernized and enlarged its refinery at Sunburst, Montana. The Capitol Oil & Refining Co. has built a 350 bbl. plant at Cheyenne, Wyoming, and the Denver Refining Co. has constructed a 500 bbl. cracking plant at Denver, Colorado. At Wichita, Kansas, the Derby Oil Co. has added to its plant a vacuum tower for the manufacture of asphalt. Skelly Oil Co. has reconstructed its cracking units at El Dorado, Kansas.

Malco Refineries Inc., of Artesia, New Mexico, recently signed a contract with the Ralph M. Parsons Co. for a 700 bbl. Dubbs cracking unit consisting of a special furnace and high pressure reaction chamber together with other items of equipment. The unit will include a hot oil pump, gas engine driven, to operate either on cracked or natural gas. Work on this plant is to begin immediately.

As the principal oil producing section of the country Texas naturally has been the scene of much activity in refinery construction and extension. Several new plants have been erected during the year by independent companies while the majors have given more particular attention to amplifying their already extensive facilities.

Taiwan branch, gasoline refining plant of the Nippon Oil Company.



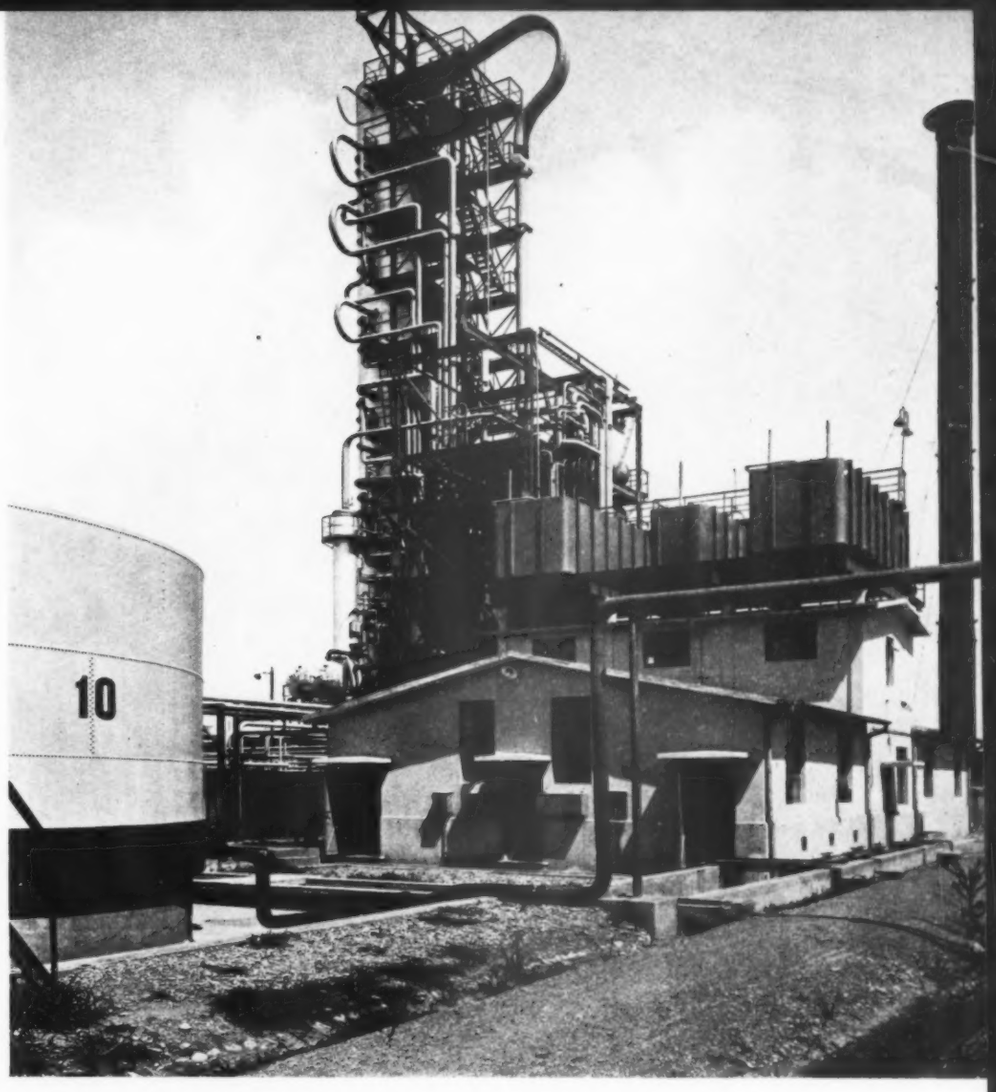
Magnolia Petroleum Company's plant at Beaumont, Texas, designed by Max B. Miller & Co. for the production of a special high grade lubricating oil has been described in a previous issue of WORLD PETROLEUM. In addition the company has installed a combination unit at Beaumont, an atmospheric rerun still charging 6,000 bbl. daily of bright stock solution and a vacuum rerun still charging 1,400 bbl. daily of solvent treated lube oil. This installation was made by Foster Wheeler. The company also is engaged in revamping its cracking units at Luling, Texas. A combination skimming-cracking unit at Beaumont is designed for a charging capacity of 33,000 bbl. and will be one of the largest of its kind in the world. Construction will be in charge of M. W. Kellogg Co.

The Texas Company is adding a furfural solvent treating unit and a dewaxing plant to its great establishment at Port Arthur, Texas, and is making additions to its asphalt plant located there. Gulf Refining Co. likewise is adding a solvent treating and dewaxing plant to its Port Arthur facilities. The plant will have a charging capacity of 5,000 bbl. distillate per day.

As part of its very extensive development program Shell Petroleum Co. has installed a large crude prestabilizing unit at its Houston refinery, is constructing a polymerization plant at South Houston and is revamping its cracking units at Arkansas City, Kansas. The prestabilizing unit was installed to overcome excessive gas losses at the Houston refinery.

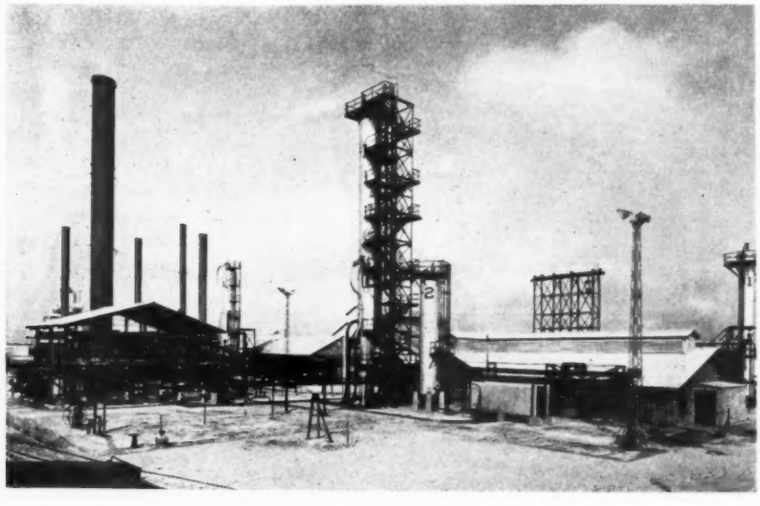
The presence of propane, ethane and methane in the East Texas crude run at the refinery produced large quantities of gas that would not condense at the normal pressure and temperature of the distillation unit separators.

A contract was placed with Alco Products Inc. for a prestabilizing unit designed to charge 44,000 bbl./day of crude to two flash towers which remove the propane and lighter element while maintaining the endpoint of the flashed material at 270 deg. F. Bottoms from the flash towers are fed to the distillation units where no gas loss occurs. The condensed overhead from the flash towers is mixed with the 270 deg. E. P. gasoline from distillation units and fed to a fractionating tower where all of the propane and lighter, and a large quantity of butane are taken overhead and condensed. This light overhead material is fed to present fractionating units where liquid butane and propane are made. The bottoms are blended with the finished gasoline to control vapor pressure. A Foster Wheeler refining heater with a daily capacity of 10,500 bbl. of straight run gasoline is being installed at Houston to operate in conjunction with a Dubbs reforming unit.



The new refinery of the Creditul Minier at Brazi-Prahova, Roumania.

A Dubbs reforming unit in Mexico.



In East Texas the gas released from the separators is rich in gasoline content. Normally some type of absorption plant would be used if the gas was to be sent to a pipeline under its own pressure. However, a large part of this gas is compressed to pressures of 250 to 200 lbs. and returned to the oil sands for repressuring purposes.

It is desirable to recover the gasoline from this gas before returning it to the oil sands. Dealing with this problem for Sinclair Prairie Oil Co. at Gladewater, Texas, Alco Products has designed a plant particularly for this purpose in which 15 mm. scf. per day of gas, containing roughly four gallons of 26–70 gasoline per thousand cubic feet, are compressed to 250 lbs. and fed to a vapor fractionator which recovers as a bottom product all of the pentanes and heavier and a large part of the butane. These bottoms are then stabilized for required vapor pressure

A striking air photo of Petit Couronne refinery in France showing recent additions. Loading port may be seen in the background.

C.A.F. Paris

in a second column. The vapor pressure may be varied from 12 to 26 lbs. Reid. This type of unit involves low initial and operating costs.

A new factor in the Texas refining situation is Solvex Refineries Inc., which is establishing a thoroughly modern plant at Gladewater. The company is constructing a 1,500 bbl. Dubbs cracking unit to crack East Texas crude into gasoline and a specification fuel oil. In addition it will manufacture special naphthas and Diesel oils. A complete vapor recovery plant with a stabilizer and debutanizer will be erected.

Crown Central Petroleum Corporation of Houston, Texas, is replacing its shell still battery with a two stage distillation unit for atmospheric and vacuum operation. The unit will have the capacity to process 16,000 bbl. per day of East Texas crude for the production of gasoline, naphtha, kerosene, furnace oil, gas oil and reduced crude bottoms which will be subsequently processed in the company's existing cracking plant.

The unit has been designed with a high degree of flexibility so that it will process 5,000 bbl. per day of Mirando crude, producing furnace oil, light, intermediate and heavy lubricating fractions and a residual product which can be utilized for road oil production. The material for the plant will be supplied by Alco Products of their own design, and will be erected by the Crown Central Corporation under Alco supervision.

The furnace for this plant is of improved design, giving low exit flue gas temperature and high over all efficiency for the various operating conditions, which is not generally obtained in atmospheric and vacuum operation. A steam generator of bent water tube design with fusion welding is being supplied by Henry Vogt Co. It is designed for a maximum capacity of 75,000 lbs. steam per hour.

Other additions to Texas refining facilities include a 4,000 bbl. combination skimming and cracking plant of Premier Refining Co. at Gladewater, a 5,000 bbl. skimming plant of Taylor Refining Co., at Pt. Isabel, a 1,000 bbl. skimming plant of the Sullivan City Refining Co. at Sullivan City, a 7,500 bbl. cracking unit of Southport Petroleum Co. at Kilgore and a 500 bbl. skimming plant of the Ralph Fair Oil Co. at Harlinger. Republic Oil Co. is constructing a vapor recovery and stabilizing unit at Texas City; Panhandle Refining Co. is adding crude distillation equipment at Leuders; Howard County Refining Co. is installing a 2,500 bbl. pipe still at Big Spring, and the Independent Refining Co. is rebuilding its plant at Texas City.

An interesting and unusual plant is the control unit erected by T V P Corporation at Texas City which is in every essential detail a replica of a commercial plant though with a charging capacity of only five barrels daily. It has been in operation four months during which time runs have been made on a variety of charging stocks ranging from naphthas to heavy reduced crudes.

A noteworthy feature of this unit is the incorporation of a conventional pipe still for heating the cycle gas in place of the stoves formerly used in this process. This development, together with the elimination of the absorption plant, lends a high degree of efficiency to the process at a minimum capital cost. Before making this change an exhaustive study was made of the possible effects upon the gas in its relation to the cracking operation. The results not only show more satisfactory work but an improved yield and quality of gasoline with increased operating flexibility. In designing this unit particular attention was given to simplicity of arrangement and economy in construction as applied to a large installation consistent with the best refinery practice. The major elements are a furnace, flash drum, reaction chamber, scrubber and fractionator with suitable exchangers and condensers.

The charging stock with the recycle stock is fed, in heat exchange with the vapors and hot gas, into the vaporizer which discharges into the flash drum. The vapors from the flash drum go to the superheater coil, thence into the reaction chamber. The heated cycle gas may be

handled in several ways or a combination of ways best suited to the particular grade of charging stock in process. It may go in any proportion into the flash drum to assist vaporization to any desired extent; it may go in part through the superheater, mixed with the heated vapors, or it may be commingled partly with the superheated vapors as they enter the reaction chamber.

The products from the reaction chamber enter the scrubber at a point near the bottom and serve as a stripping medium for the flash drum bottoms which are discharged into the scrubber and flow counter current to the ascending vapors. The vapors from the scrubber pass through heat exchangers into the fractionator, and the fractionator bottoms are used partly as reflux to control the scrubber temperature. The remainder of the fractionator bottoms is the recycle stock which is returned to the vaporizer with the fresh feed. The scrubber bottoms are withdrawn as fuel oil.

Vapors from the top of the fractionator pass through a condenser and into an accumulator. The wet gas from the top of the accumulator goes to the recycle gas compressor, thence through exchangers and into the cycle gas heater coil. The "make" gas goes to a small absorber or, in a large unit because of the small quantity of gas involved, it may go to the regular refinery absorber, or directly to the stabilizer. The gasoline is withdrawn from the accumulator and stabilized.

The control unit is equipped throughout with temperature and pressure recording instruments and at all necessary points with the usual automatic controls.

An outstanding feature of the process is the high octane rating of the gasoline produced which, from most charging stocks, will range from 70 to 80 octane number, motor method, or from 80 to 95 research method. The finished product has an induction period of four hours, or higher, with a low preformed gum content, averaging 2 to 3 mg. per 100 cc.

Another characteristic feature of the process is the production of unusually low viscosity fuel oil, with a correspondingly low cold test and a minimum amount of sediment. The process is capable of cracking charging stocks having a wide range of boiling points without sacrificing yields or the high octane rating of the finished gasoline. Practically no coke is formed at any stage of the operation.

Mid-Continent Petroleum Company has in operation at its West Tulsa, Oklahoma, refinery a 3,000 bbl. pressed distillate atmospheric rerun unit installed early in the year by Foster Wheeler Company. Continental Oil Company has constructed a dewaxing plant at Ponca City, Oklahoma. Sunray Oil Co. at Allen, Oklahoma, has installed a 1,500 bbl. Dubbs unit to crack waxy gas oil from Allen crude.

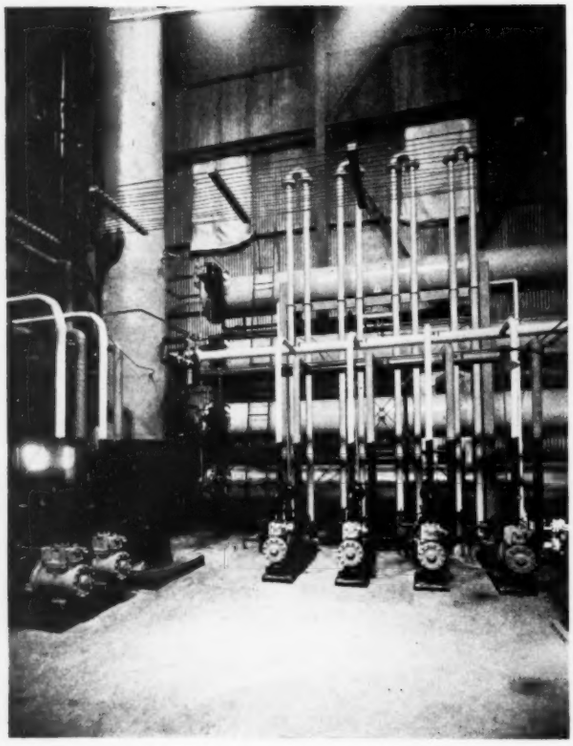
Late in 1934 Cushing Refining & Gasoline Co., Cushing, Oklahoma, signed a licensing agreement with Universal Oil Products Co. by which the engineers of the latter company took over a unit that was under construction. It has since been finished as a Dubbs cracking unit operating on topped Cushing crude and making gasoline of 67.2 octane and cracked fuel oil. A similar conversion of a non-licensed unit to a Dubbs cracking unit was made for Black Gold Refining Co. of Oklahoma City. This plant operates on Oklahoma City crude and has a capacity of 750 bbl. daily.

To overcome undesirable light materials in its raw pressure distillate, absorption plant gasoline and light natural gasoline the Louisiana Oil & Refining Co. at Bossier City, Louisiana, contracted with Alco Products to construct a specially designed tower installation. This unit handles a daily charge of 6,000 bbl. per day to a primary tower where approximately a 25 percent of volume light gasoline cut is taken overhead and condensed. The bottoms pass to the treating unit where the losses are materially reduced.

The primary tower overhead is mixed with the unstable absorption plant gasoline and natural gasoline. It is charged to a second fractionating tower where the undesired light material passes overhead as a gas. The butane recovery can be flexibly controlled to meet varying summer and winter blending demands. Vapor losses are held to a minimum by this method.

A new 2,000 bbl. cracking unit was constructed by the Lion Oil Refining Co. at El Dorado, Arkansas, utilizing in part material from a battery of fifteen abandoned Burton stills. The unit is charged with gas oil stock from a 6,000 bbl. high pressure crude unit. Topped local light crude is used as a charge along with the gas oil. The topped crude is produced on a 3,000 bbl. crude still operating on light Arkansas crudes. The gas oil charge enters the system through the bubble tower but the topped crude is injected

Gasoline plant of the Steaua Romana Company in Roumania.



Settlers and mixing columns at the chlorex plant of the Bradford Penn Refining Company.

General view of the Redaventza refinery at Antwerp.

into the transfer line as a coolant for the vapor leaving the pipestill. The coil outlet pressure is maintained at 450 lbs. per sq. in. and the outlet temperature at 940 deg. F. In the evaporator a separation of tar from the lighter vapors is effected so that the tube still charge drawn from the base of the bubble tower is a clean stock.

The pipestill is of conventional design with Detrick arch and walls, air cooled bridgewall and floor and transite roof and outside wall facing. The lower row of roof tubes and the front wall tubes are four to six percent chrome molybdenum steel while the remainder of the still tubes are of low carbon steel.

Yields from this unit under usual operation are as follows: 50 percent endpoint gasoline, 5 percent furnace oil, 40 percent fuel oil and 5 percent fixed gas and coke. Continuous runs of sixty days on stream have yielded as little as a wheelbarrow full of coke. Indicating and recording instruments have been disposed liberally throughout the unit. A Foxboro stabilog flow controller for the hot oil charging pump permits steady and positive flow of oil to the cracking still tubes. The unit operates under the patents of Gasoline Products Co. of which company the Lion is a licensee.

Activity in refining construction during the past year has been particularly marked in the Michigan field. While the new plants built or under way are of moderate size they are thoroughly modern and efficient in operation. Typical of these plants is that of the Naph-Sol Refining Co. at Muskegon which has been improved by the addition of a Dubbs cracking unit of 1,000 bbl. capacity. The unit is used to process Mount Pleasant crude or residual fuel oil, furnishing cracked gas on contract to a local distributing company.

Other new Michigan enterprises are those of Inland Refineries at Pontiac; Sweet Oil Refining Co. at Wyman; Ithaca Refining Co., Ithaca, and Crystal Refining Co., Carson City, each for a 1,000 bbl. skimming plant. Bay Refining Co. is building a 350 bbl. skimming plant at Bay City and Pure Oil Co. has added an Ethyl blending unit to its Midland, Michigan, refinery. Another Pure Oil Company installation of more than passing interest is a distillation unit of 10,000 bbl. capacity to handle Mid-Continent crude. A feature of this installation which is being made by Alco Products is a fractionating tower 110 ft. high and 12 ft. 5 in. in diameter which will produce continuously gasoline, naphtha, kerosene, gas oil, wax distillate and a heavy lubricating oil cut.

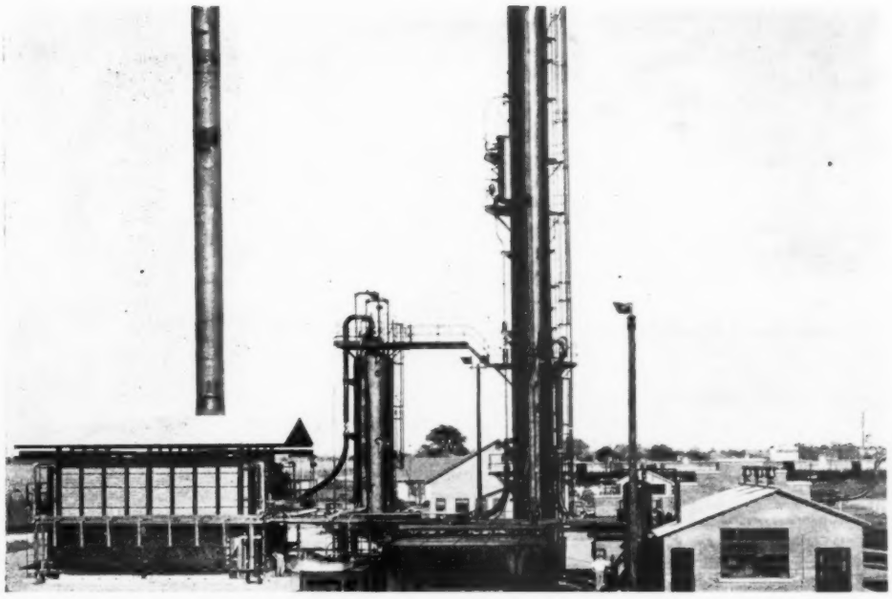
Developing one of the country's great refineries at Wood River, Illinois, Shell Petroleum Co. is engaged in a practically continuous program of expansion and improvement. Additions to this plant during the past year have included a solvent treating plant, a combination distilling and cracking unit, a 20,000,000 ft. absorption unit and a 12,000 bbl. stabilizer.

Wadhams Oil Co. has installed a M. W. Kellogg Co. crude distillation and cracking unit in its refinery at East Chicago. Shell Petroleum has installed a polymerization plant to process cracking still gas.

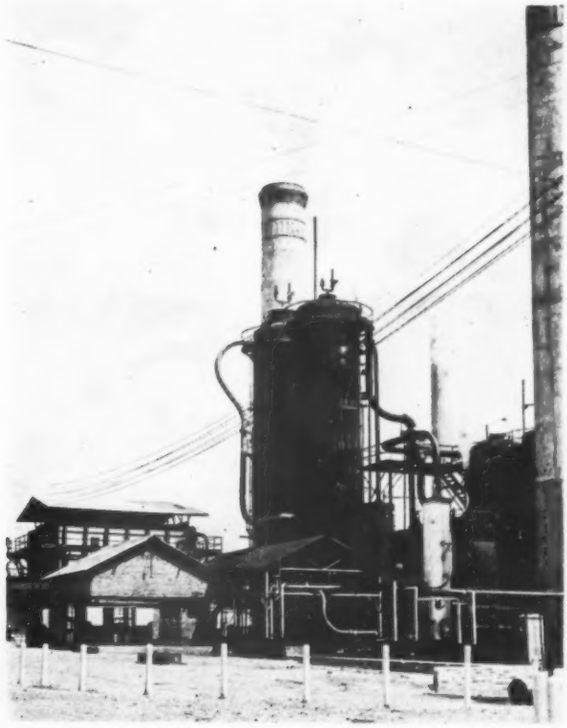
Application of solvent extraction methods to the manufacture of lubricating oil has been a leading factor in construction developments in the Pennsylvania field. Detailed descriptions of Gulf Refining Company's Duo Sol plant at Philadelphia and the nearby plant of Socony-Vacuum Corporation at Paulsboro, New Jersey, appeared in the May 1935 number of WORLD PETROLEUM.

An interesting solvent treating installation is that of the Bradford Penn Refining Co. at Clarendon, Pennsylvania, in which the Chlorex process is employed. It handles 400 bbl. of cylinder stock and 3,500 to 4,200 bbl. of neutral stock daily. Carbon residue in cylinder stock has been reduced to less than one percent as compared with 1.5 percent under ordinary methods and neutral stock to 0.02 percent as compared with the usual 0.05 to 0.07 percent.

The unit includes a raffinate and a solvent extract tower, each 30 x 3 ft. and is equipped with ten steam driven pumps. Control is entirely by automatic instruments. The Chlorex process is controlled by the Union Carbon and Carbide Co. A similar plant is being installed by the Freedom Oil Works at Freedom, Pennsylvania. This company also is installing a 500 bbl. Dubbs cracking unit to process residues from Pennsylvania crude and inferior fractions of lubricating distillate separated from the chlorex in the solvent process. It will operate also as a high temperature distillation unit, processing 800 bbl. per day.



Plant of the Sunray Oil Company at Allen, Oklahoma.



New 2,000 bbl. cracking unit of the Lion Oil Refining Company, showing tube still, evaporator and fractionator towers, gas separator and control house.

Pennzoil Co. at Oil City, Pennsylvania, is installing an atmospheric distillation plant replacing a battery of shell stills formerly in use and giving this company a modern two-stage atmospheric and distillation plant of 4,000 bbl. capacity. This installation is being made by Alco Products. When completed it will produce gasoline, naphtha, kerosene and gas oil from the atmospheric stage, with lubricating oil fractions produced under high vacuum from the existing vacuum unit.

The atmospheric stage has been designed with sufficient flexibility so that additional fractions may be removed, depending upon future conditions.

This is the eighth complete distillation unit which Alco Products has installed in the Pennsylvania field, in addition to various miscellaneous equipment.

United Refining Co., at Warner, Pennsylvania, has remodeled to operate the Dubbs process a unit formerly used for refining. It includes a flash chamber, bubble tower and hot oil pump and will crack gas oil or other charging stock as well as reforming straight run gasoline.

To replace its filter plant and part of its shipping department at Coraopolis, Pennsylvania, which was destroyed by fire during the past summer the Canfield Oil Company placed a contract with the Austin Company for reconstruction of the damaged property. The work now practically completed, included new pressure type filters, conveying machinery and accessory equipment.

Atlantic Refining Company has added a clay treating unit to its Philadelphia refinery and Crew Levick Co., subsidiary of Cities Service Co., has installed a 2,000 bbl. distillation unit at Titusville, Pennsylvania. Cities Service also has added a skimming and cracking unit to its plant at East Braintree, Mass. Franklin Creek Refining Co., at Franklin, Pennsylvania, has installed a 1,200 bbl. Badger crude unit and a 2,000 bbl. Badger rerun unit. At East Providence, Rhode Island, E. B. Badger & Son have constructed an asphalt plant of 1,000 bbl. capacity for American Bitumuls Co.

Most significant of the new developments in Canadian refining during the year was the entrance of Standard Oil Company of California through its subsidiary, Standard Oil Company of British Columbia Ltd., as a competitor in this field. In June last the company broke ground at Burnaby, British Columbia, for a complete new refinery of 2,000 bbl. daily capacity. The new plant will occupy a site of fifty-five acres with a 400 ft. wharf at which tanks can discharge the California crude which is to be treated.

The refinery will produce the company's standard brands of gasoline, kerosene, motor oils and gasses, Diesel oil, furnace oil, gas oil and residual fuel oil. Sufficient flexibility has been incorporated in the basic design so that additional equipment may be installed for future production of asphalt and road oils in accordance with market demands. The distillation unit is of Alco Products standard design and the entire construction and installation of the unit together with the yard piping is being undertaken by Alco Products in cooperation with the engineering department of the Standard Oil Company.

Practically all of the material will be of Canadian manufacture, either from the shops of the Montreal Locomotive works or from Canadian manufacturers on the Pacific Coast. Local labor will be employed in construction.

Lloyd Refineries Ltd. of Toronto, Canada, is building a Dubbs cracking unit to handle a daily charge of 700 bbl. of Michigan crude. The installation has a full flashing unit but is so designed that it can run on coke if desired.

Shell Oil Company of Canada has installed a Dubbs cracking and reforming unit of 5,500 bbl. daily capacity. The topping is done by waste heat. The unit consists of two furnaces, two bubble towers, one for crude oil and one for cracked oil, a reaction chamber and a flash chamber with the necessary auxiliary equipment. It processes a high yield of gasoline and a low yield of fuel oil of low pour point, low carbon residue and low viscosity. In a continuous 24-day run it processed 130,000 bbl. of crude oil and produced 16,500 bbl. of straight run gasoline of 57 octane and 182,000 bbl. of low end-point straight run gasoline of 68 octane. From 93,000 bbl. of topped crude it produced 46,500 bbl. of cracked gasoline of 69 octane and 35,000 bbl. of fuel oil 12.3 A P I gravity and 83 seconds viscosity Saybolt. This is a total of 81,000 bbl. of gasoline averaging 66 octane or 63 percent

Gasoline driven Lincoln Electric welder in use at a large Texas refinery.

of the crude, with 27 percent fuel oil and only 10 percent fuel loss.

Comet Oil Refineries Ltd., of Montreal, Canada, is installing a 2,000 bbl. Dubbs cracking unit to handle crude from Louisiana and Texas Gulf Coast where the company has extensive crude production.

Compania Mexicana de Petroleo El Aguila has installed in its refinery at Tampico, Mexico, a Foster Wheeler reforming heater with a daily capacity of 3,200 bbl. of straight run gasoline operating in conjunction with a Dubbs reforming unit. At Puerto Mexico a pipe still for topping 10,000 bbl. daily of crude oil has been installed.

Partly as a result of the United States tariff on oil which is diverting a larger share of Venezuela's output to European markets extensive additions have been made to the refineries of Curacaosche Petroleum Ind. Mij. (Royal Dutch Shell) at Curacao, D.W.I. and of the Lago Oil Company and Arend Petroleum Company at Aruba, D.W.I. At the Curacao refinery which is ranked as the largest in the world the additions include reforming and cracking units with stabilizers and absorption columns to process naphtha and distillate, producing finished gasoline of about 70 octane. A reforming heater handling 10,000 bbl. daily of straight run gasoline was supplied by Foster Wheeler in conjunction with a Dubbs reforming unit. New equipment at the Arend Company's Aruba plant includes a cracking unit with fractionating columns, reaction and flash chambers, stabilizers and absorption columns. Additions to the Lago Company's Aruba plant have been in continuation of the parent company's program of building up capacity and equipping the refinery to produce higher specification gasoline which has been under way for the past two years. Recent installations include a two-stage atmospheric and vacuum crude still.

A project which is now going forward after a year's delay is that of ANCAP (Administracion Nacional de Combustibles Alcohol y Portland) for a refinery at Montevideo, Uruguay. This plant which is being constructed by Foster Wheeler Company will have a daily capacity of 3,800 bbl. of Ecuadorian crude and will include a topping unit, a Dubbs cracking unit, a debutanizing plant, a gasoline and kerosene treating plant, steam generating station, pump house, storage and residences for operators. It will have an annual output of 500,000 to 560,000 bbl. of straight run gasoline, 50,000 to 60,000 bbl. of gas oil and 250,000 to 300,000 bbl. of fuel oil.

In Argentina the Standard Oil Co. (New Jersey) has been engaged in rebuilding its refinery near Buenos Aires which was destroyed by fire last year. Shell Oil Company has installed a new reforming unit to produce high octane gasoline. Yaciemintos Petroliferos Fiscales, official government company, is considering the erection of a small refinery to handle production from the Mendoza field.

Separate articles dealing with refinery developments in the United Kingdom, France, Italy, Roumania and the Soviet Union appear on other pages of this issue. In other parts of the Continent important new construction is under way or projected for early action. Information as to one of the largest of these enterprises is still being held confidential as the exact location and some of its features are not ready for announcement. It will include, however, a selective reforming and cracking unit to crack 9,000 bbl. per day of South American crude and to reform 3,500 bbl. of straight run gasoline to yield high octane motor fuel. It will include also stabilizing and absorption equipment and other features of a thoroughly modern plant.

A notable addition to the refining facilities of Belgium is the new plant of the Redeventza S. A. Belge on the River Scheldt at Antwerp which began operation at the end of August. The company is associated with Redeventza of Roumania and the plant was built to take advantage of the protective tariff imposed on imports by Belgium. Besides participating in the domestic market it is expected to export products to neighboring countries.

The plant has a capacity of 2,100 to 2,800 bbl. per day. It consists of a Foster Wheeler atmospheric distilling unit supplied under license by Borsig of Berlin and erected under supervision of Dr. Knecht of the latter company. Harold Moore of London was consulting engineer to Redeventza.

The distillation unit is designed to provide one overhead vapor product, three side streams and one residue stream. When handling the charging stocks at present contemplated its products will be gasoline, white spirit, kerosene, gas oil and fuel oil.

The combination of Foster Wheeler patented weir control valves and internal stripping sections enables the specifications of the various products to be closely controlled, the end point of the side streams being regulated by the weir control valves and the initial boiling point or flash point controlled by injection into the internal stripping section of stream which has been superheated.

The power plant of this refinery consists of two Babcock & Wilcox boilers fitted with superheaters and economizers, each having a heating surface of 220 square meters and each capable of generating approximately 18,000 lbs. of steam per hour.

In Germany the Deutsche Vacuum Oil A. G. has completed arrangements for construction at Bremen of a solvent treating plant after designs by Max B. Miller & Co., similar to plants which Socony-Vacuum, the parent company, is constructing in the United States, France and Italy. The year has witnessed the completion of the large refinery of Europaische Taukloger und Transport A. G. at Hamburg which was described in WORLD PETROLEUM last October. It also has been marked by considerable activity inspired by the German government, in the projection of hydrogenation plants for the recovery of motor spirit from coal.

In Czechoslovakia the Fanto Werke A. G. contemplates the construction of a cracking plant at Pardubice. Another Czechoslovak refinery at Bratislava will include a Dubbs full flashing selective cracking unit with continuous coking equipment and a vacuum flashing system, stabilizer and absorber. It is designed to process 900 bbl. daily of Gura Ocnitzei paraffin base crude. It is also adaptable to the production of asphalt and with this operation added will have a charging capacity of 1,100 bbl. daily. The unit will be

High pressure stop and check governors of new design built to withstand pressures of 3,700 lb. They were built by Foster Engineering Company for shipment to the Soviet Union.

built by Skoda Works of Prague. At Cracow, Poland, a Foster Wheeler distillation unit is being built for Zielenievski i Fitzner Gamper and in Finland local financial interests plan to take over and rebuild the Wallenberg shale oil plant at Kohtla in East Estonia, raising its output to 84,000 bbl. yearly.

It is reported also that CAMPSA, the Spanish company holding a government monopoly, will construct a new distillation unit at Santander.

The Near East has been teeming with activity during the year and this has included important developments in the refining field as well as in production. The Anglo-Iranian Oil Company has gone forward with its program of expansion at Abadan, Iran, making its refinery there one of the outstanding enterprises of its kind in the world. Recent additions include a two-stage atmospheric and vacuum unit, the largest pipe still ever built, with a capacity of 35,000 bbl. per day. The atmospheric tower is 90 ft. high and 20 ft. in diameter and the vacuum tower is 92 ft. by 25 ft. On account of their great size they will be fabricated in the field, the work being done by two prominent British firms.

The hot topped crude will be pumped direct from the primary flash column through two parallel pipe stills into the atmospheric column which will produce a light overhead cut of 8 and 10 percent and side streams of kerosene, approximately 6 percent, gas oil 14 percent, and topped crude, approximately 40 percent.

The hot topped crude will be pumped through a second pipe still direct to the vacuum tower, the latter producing a gas oil overhead and wax distillate side stream and pitch bottoms from the base. The overheads from the primary flash column and the atmospheric column will be condensed and passed to their respective run down tanks from which cold pumped reflux will be supplied to the respective columns. The side streams from the atmospheric column will flow through heat exchangers and final coolers to their rundown tanks. The overhead from the vacuum tower will pass through a vapor heat exchanger final condenser to the rundown tank.

The design of this equipment is being supplied by Alco Products and is being fabricated in Great Britain. Persian labor is performing the work of erection under Alco engineering supervision. Another installation at Abadan is a 60,000 bbl. topping and vacuum unit supplied by E. B. Badger & Sons in conjunction with British engineers. Anglo Iranian also is installing a 10,000 bbl. Alco stabilizing unit.

Now in its final stages of completion is the rectifying treatment plant erected at Kermanshah, Northwest Iran, by the Kermanshah Petroleum Company, subsidiary of the Anglo-Iranian Oil Company, Ltd. The plant is rather novel, being built in conjunction with a field distillation plant, and is designed to absorb any surplus product that the local marketing department cannot dispose of. This surplus varies with the seasonable demand. It must be borne in mind that the task was not an easy one owing to the local consumption of white oils being out of proportion to black oil, and distances too great to permit transportation to other markets.

On the Naft-i-Shah oilfield itself has been erected the distillation plant, consisting of a pipe still, fractionating tower, steam raising and water units. Here the heavy crude oil is blended by mixing the products from the fractionating tower with a proportion of the residue. Blends are varied at will and the cuts are stored separately ready for mixing as desired.

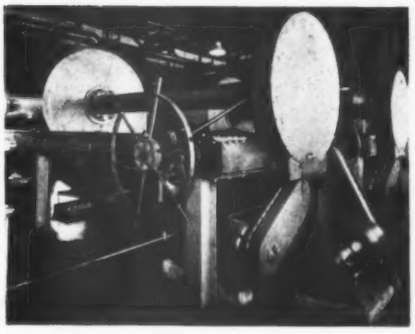
From this distillation plant the crude is pumped through a seamless three-inch pipeline, 158 miles long, to Kermanshah. Naft-i-Shah is 520 ft. above sea level, and the pipe line goes as high as 5,350 ft. dropping down to 4,400 ft. at the refinery. Pressure is 150 lbs. per sq. inch and the power is supplied by Diesel and steam driven pumps. Telephone and telegraph systems connect the two plants.

At Kermanshah the crude is rerun to produce benzine, kerosene, gas oil and fuel oil. The plant consists of a pipe still unit with fractionating column, together with acid manufacturing and treatment plant for the production of finished products. High anti-knock motor spirit is produced for aviation purposes from a blending plant. There also is a canning and filling plant with modern conveyor system and road-tanker loading rack. For power and process purposes there is a Diesel-generating station and a steam boiler unit.

Finally, it may be mentioned that as the entire Naft-i-Shah-Kermanshah installation is a complete unit, embodying drilling, production, refining, transportation and marketing, and as it meets the requirements of an isolated area without throwing surplus products on other markets, it may be regarded as unique in the history of petroleum engineering.

For the Iraq Petroleum Co. Foster Wheeler are building at Kirkuk, a stabilization unit in three sections which will process 120,000 bbl. daily of Iraq crude prior to its conveyance through company pipe lines to Haifa and Tripoli on the Mediterranean.

The government of Iraq itself has projected a refinery to supply domestic needs but details regarding it have been withheld.



Two of four rotexo filters made by Oliver United and installed in an important refinery in Philadelphia.

Now that Standard Oil Company of California has developed extensive production in Bahrein and has every indication of opening another important producing field in Saudi Arabia the question of a refinery to deal with this output presents itself. Under both its concessions the company is obligated to build refineries to supply local needs. It is not denied that the subject is under consideration but no definite announcement has been made by the company as yet.

A Foster Wheeler atmospheric distillation unit of 1,400 bbl. daily capacity is being added to the Suez refinery owned by the Egyptian government. The unit is designed to operate under atmospheric conditions running crude oils to fuel oil residues or under vacuum running Hurghada residue to asphalt.

Gasoline is obtained as an overhead product, kerosene and gas oil, light and heavy wax distillates as side streams. Following the successful operation of this unit the Egyptian government is now installing a Foster Wheeler atmospheric distilling unit of 200 tons daily capacity.

A refinery in Tripoli to treat 315,000 bbl. of crude yearly and to supply the local market with gasoline, fuel oil and other products has been projected by Azienda Commerciele Italiana Olii Minerali of Genoa and is understood to have the approval of the Italian government.

In Southern Africa rapid strides are being made in the project for recovery of oil from shales which is being pushed by the South African Torbanite Mining & Refining Co. Ltd., a subsidiary of Burmah Oil Company. A shaft has been sunk 600 ft. to the torbanite seam at Ermelo. Two Salermo retorts are being erected capable of treating 150 tons of shale daily. From these the crude oil will go to large storage tanks which are being put in position. Construction of the refinery at Boksburg which is to have a capacity of 1,000 bbl. daily is well advanced. Storage tanks

have been built at Durban to receive imported crude oil for preliminary operation of the refinery as crude oil production at Ermelo will not begin until well toward the end of this year.

In India the Assam Oil Co. is converting a Dubbs unit at Digboi into a full flashing two-coil selective cracking and coking operation by adding a new furnace and other necessary equipment. The unit will have a daily capacity of 600 bbl. Burmah Oil Co. has contracted with Alco Products for a 1,600 bbl. stabilizing unit designed to produce either a 5 lb[s] Reid bottom product or to retain 95 percent of the butanes in the bottom when charging Dubbs pressure distillate or a 290 deg. endpoint straight new gasoline. Another Indian Oil Company is planning the installation of a solvent treating plant but is not yet ready to make an announcement.

In the Far East Standard Vacuum Oil Company has continued the enlargement of its Palembang, Sumatra, refinery which was the subject of a special article in WORLD PETROLEUM last year. Another Netherland Indian refining company is installing a Dubbs cracking unit to reform 8,500 bbl. of naphtha daily. The unit includes a stabilizer, absorber and residue stripping equipment and converts charging stock into a gasoline of 374 endpoint.

A Dubbs selective cracking unit of 850 bbl. daily capacity has been installed in the refinery of the South Manchurian Railway Co. Ltd., at Fushun, Manchukuo to process Manchukoan shale oil with low pressure continuous coking. A company known as the Korean Petroleum Co. with a capital of $3,000,000 has been formed by Japanese interests to build a refinery in Korea but plans have not been announced.

▼

Cracking's Contribution to Refining Progress

Tolerated at First Only as a Means of Increasing the Supply of Motor Fuel It Has Come to Be Recognized as Being Indispensable to Modern Motoring.

SINCE the first commercial cracking unit was fired up for its first profit-making cycle, the attitude of refiners toward cracking has undergone one change after another. Frequently the changes have been rapid as cracking has demonstrated time and again its ever-widening usefulness.

At first the cracking process was credited with just one virtue; it made more gasoline when gasoline was sorely needed to keep pace with the rapid march of automobile development. Cracked gasoline was gasoline but its quality was held to be inferior to that of the sparkling white, high gravity straight-run gasoline that was distilled from crude oil.

Refiners who did not have cracking units derided the value and condemned the quality of cracked gasoline. Even the few who made cracked gasoline had small faith in its quality. They blended it off with their prize straight-run fuel in as large a proportion as they could manage and said nothing about it.

Learned research men in government laboratories and elsewhere shook their heads and doubted. They wondered how much cracked gasoline the refiners would ever be able to get away with and how much cracked the straight-run would be able to absorb without too great contamination. These doubts and fears are matters of record.

Cracked gasoline first won full respectability in the eyes of the refining world when research detectives in automotive laboratories tracked down the knock in the automobile engine and convicted gasoline of responsibility.

Then it was found that cracked gasoline ran more quietly and performed more powerfully than straight-run gasoline in the engine, and from then on cracked gasoline has held its rightful place in the motor fuel field and its importance in the market has consistently increased.

That development brought the first important change in the attitude of refiners toward the cracking process.

It is not many years since the whole scheme of the average refiner was to make from his crude oil gasoline, kerosene and fuel oil, all of which were usually salable at prices that represented a good profit. Sometimes fuel oil sold at a loss, but even so gasoline brought a price that could cover the loss and still show a profit on the operation as a whole.

But conditions changed, in relation both to crude supply and marketing practice; they became steadily more difficult.

For the past three or four years it has become necessary for the refiner who would prosper, or even survive, to make a gasoline of high antiknock value. He could not otherwise hold his market. Cracking has proved to be the way out.

And it became more and more difficult for the average refiner to make such gasoline at a profit unless he was able to get a high yield, which meant the cracking process must be able to convert the greatest possible percentage of the crude into gasoline.

Research and development work has been constantly improving the efficiency and economy of the cracking process to keep it more responsive to the refiners' more exacting needs.

In the early days, the only stock that could be commercially cracked was a selected gas oil, because residual oils formed coke so rapidly that the cracking cycle was cut short and the operating costs rose to prohibitive heights. As the demand for cracking increased, however, the necessity arose of making it adaptable to the widest variety of charging stocks and the widest variety of operations. The coke obstacle was overcome by the clean circulation feature and other improvements.

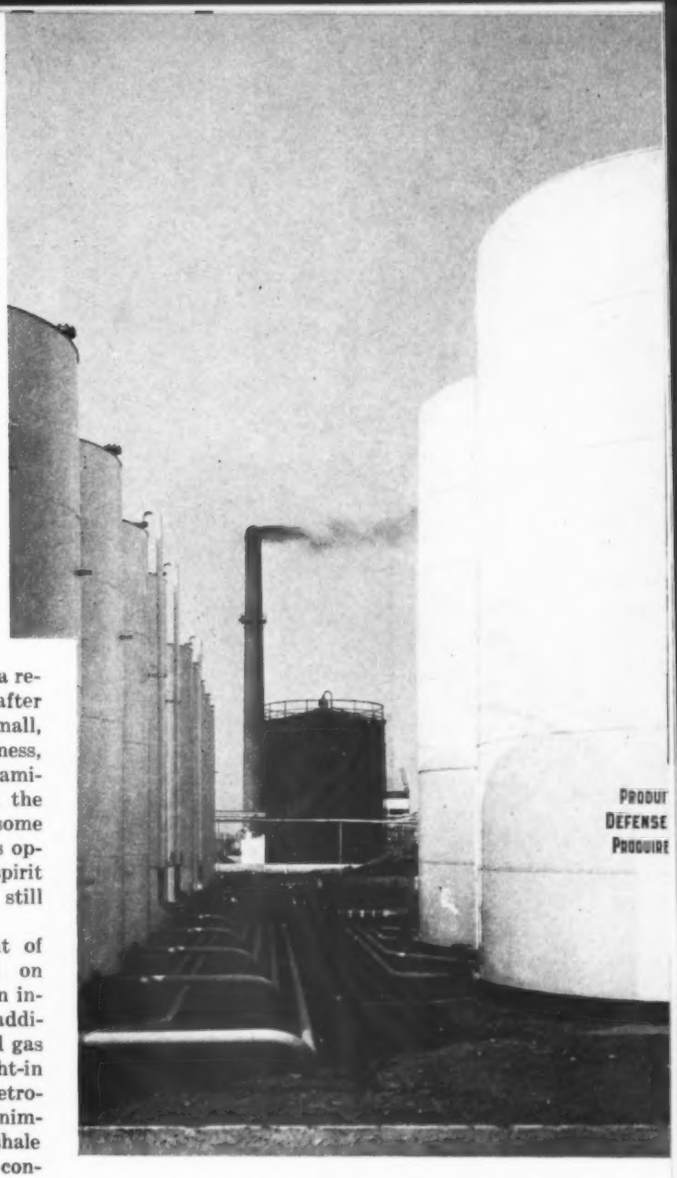
So the next change in the attitude of refiners toward the cracking process came when it demonstrated its ability to crack successfully and economically any kind of charging stock that could be pumped, and to convert it into superquality gasoline. Now it even converts or reforms

(Continued on page 623)

British Refinery Output Declines

One of the First Countries to Have An Oil Refining Industry, Great Britain Now Avoids Artificial Encouragement to the Refining Industry.

By Alec Day



Loading tank of the Redamentza refinery at Antwerp.

BRITAIN'S oil-refining activities started many years before Colonel Drake discovered petroleum in Pennsylvania. James Young, whose name is still preserved in the title, "Young's Paraffin Light & Mineral Oil Company" (now controlled by Anglo-Iranian), carried out his first experiment in 1847, and was actually operating a refining plant on a commercial scale in 1850.

As early as 1865 James Young, Jr., introduced the cracking of the heavier fractions of shale oil. The patent which he took out in December of that year describes this cracking as a process to convert the hydrocarbon oils into oils of a lighter nature by heating and distilling under a pressure of about 20 lb. per square inch, "the distilling vessel to be capable of resisting at least 100 lb. to the square inch."

Although this early start in refining was actually concerned with shale oil, it included methods similar to some of those in use at the present time for petroleum. Nevertheless, it was followed by so long a period of inactivity in the development of petroleum refining that the leeway lost has by no means been made up by subsequent extensions in the British industry.

Lacking the stimulus of a domestic supply of crude, Britain neglected refining until after the European War. Although the emergence of the motor-car had indicated the supreme economic importance of petroleum long before that time, refining facilities within the country remained negligible.

Such firms as Carless Capel and Leonard carried on refining on a small scale before the close of the nineteenth century; but their operations were practically confined to the distilling of special industrial spirits and solvents. The business taken over by London and Thames Haven Oil Wharves on its formation in 1898 was started as early as 1876, but it was left to London and Thames Haven to build a refinery. This was not done until after 1900 and even then the plant was small, and was used not in refining as a business, but for eliminating the effects of contamination of oil products arising from the shipment of mixed cargoes. When some years later the company extended its operations to the distillation of white spirit for its customers, its refinery was still limited in scope.

Naturally, a considerable amount of petroleum importing was carried on before the war, Britain consuming an increasing amount of motor spirit in addition to kerosene, and lubricating and gas oil. These products were brought-in refined, consequently the country's petroleum refining industry remained unimportant, although the Scottish shale industry had meanwhile grown to considerable dimensions.

It was not until the Anglo-Iranian, then the Anglo Persian Oil Company, commenced work on its big Llandarcy plant, that a move was made towards creating an effective refining industry in Britain. The Llandarcy project, which was conceived in pre-war days, followed the acquisition of a large share interest in Anglo-Iranian by the British Government. War time exigencies prevented it from being completed before 1921, but this lead was soon followed by the erection of other refineries, the Agwi Plant at Fawley Southampton, being among the first to come into operation. Concurrently, many of the undertakings formerly handling oil products in Britain entered the refinery business more whole-heartedly. These concerns included Cory's and London and Thames Haven. As a result of these developments British refinery capacity grew rapidly for several years, until Great Britain possessed a well-spread chain of plants circling its coast from Southampton in the south of England, to Ardrossan and Grangemouth in Scotland, with the largest concentrations of plant in the Manchester and London areas.

Ownership of the main refineries is a matter of considerable interest. The majority of the plants are British owned, but several important refineries are under ultimate American control, the two largest being the Agwi Refinery and the Ellesmere Port works of the Anglo-American. Dutch capital, too, may be said to have a two-thirds share in the Shell Refineries' plants.

During recent years the rate of expansion of British refining capacity has slowed down considerably, while British consumption of petroleum products has increased, and the proportion of the total demand supplied by home refining has declined steadily. As shown by the accompanying tables, the percentage of home production of five major petroleum prod-

Fawley refinery and loading dock of the Agwi Petroleum Corporation, Ltd. Since the photograph was taken several important additions have been made to the plant and a considerable number of tanks have been erected.

ucts to apparent consumption has declined from 22.3 percent in 1931 to 12.2 percent in 1934.

Total throughput of British refineries increased last year to 16,100,000 bbl., compared with 15,600,000 bbl. in 1933, but was still well below the figures for the years 1929–1931. A notable feature of recent trends was the continued decline in the re-treatment of refined and semi-refined products, which was only 1,900,000 bbl. in 1934 against 5,900,000 bbl. in 1929. Faced with the greater economic efficiency of petroleum and a period of relatively low selling prices, the Scottish shale industry has lost its former prosperity. Some of the works formerly engaged entirely on shale, including those at Oakbank, Pumpherston and Uphall, have been employed largely on petroleum treatment since Scottish Oils Limited, the controlling company, was taken over by Anglo-Iranian. The relative insignificance of the shale industry at the present time may be gathered from the fact that shale oil produced is now valued at less than £500,000 annually.

Liquid output of British refineries has been declining more rapidly than refinery throughput, although the output of gas oil and lubricating oil actually increased between 1929 and 1934. Fuel oil and motor spirit production in Britain has fallen off consistently for some years, and as these are the largest items in the list of products, the total output of liquids was only 11,900,000 bbl. last year, compared with 17,300,000 bbl. in 1929. The fall is only partly attributable to the decline in throughput, the proportion of liquid output to throughput declining during the period from 85 percent to 74 percent.

Accompanying the decline in liquid output, there has been a rapid increase in the production of solids at British refineries. Progress in this department is shown in the accompanying comparison.

Output of Solid Products of British Refineries

Year	Tons
1929	322,389
1930	336,469
1931	385,697
1932	376,321
1933	402,297
1934	488,202

Taken as a whole, the figures show clearly that the recent trend of British refining has been towards production of a larger proportion of heavy materials, such as asphalt, at the expense of motor spirit and fuel oil.

Nevertheless, after making all allowance for the increase in output of solid products, British refineries have turned out an ever-decreasing percentage of the nation's requirements of petroleum in recent years.

Although by taxation of fuel oil entering Britain, and by the duty preference of 4d per Imperial gallon on light oil produced from British coal, shale or peat, the government has sought to assist the new coal-oil industry, thus endeavouring to aid the domestic coal trade, no steps have been taken to encourage home petroleum refining along lines recently adopted by the major Continental petroleum-consuming countries. Recent indications are that the government is not likely to take any steps in this direction, regardless of appeals by some of the British independents. The majority of oil men regard artificial encouragement of domestic refining on anything like a substantial scale to be an uneconomic plan, and that such steps would bound to increase the price of motor spirit to the consumer. At the present time exchange agreements with other countries, such as Denmark, enables quite a little quantity of the British refinery output to be exported, particularly where better prices can be secured.

Output of Liquid Products of British Refineries

	Barrels	Percentage of Liquid Products to throughput
1929	17,300,000	85
1930	16,700,000	84
1931	14,500,000	81
1932	12,600,000	79
1933	12,100,000	78
1934	11,900,000	74

ONE of the country's major refineries is operated by Agwi Petroleum Corporation Ltd. at Fawley on Southampton Water and is controlled by the Standard

Oil Company of New Jersey. Fawley refinery was commenced in August, 1920, on a site on the southwest shore of Southampton Water at Fawley, and occupies an area of approximately 650 acres, with a frontage of 1¼ miles. Considerable sums of money have been expended to keep the plant up-to-date, in fact about £50,000 is being spent during the current year for new units.

The refinery consists of full refining units capable of manufacturing motor spirit, kerosene, gas oil, Diesel oil, fuel oil and asphalt for British and export business.

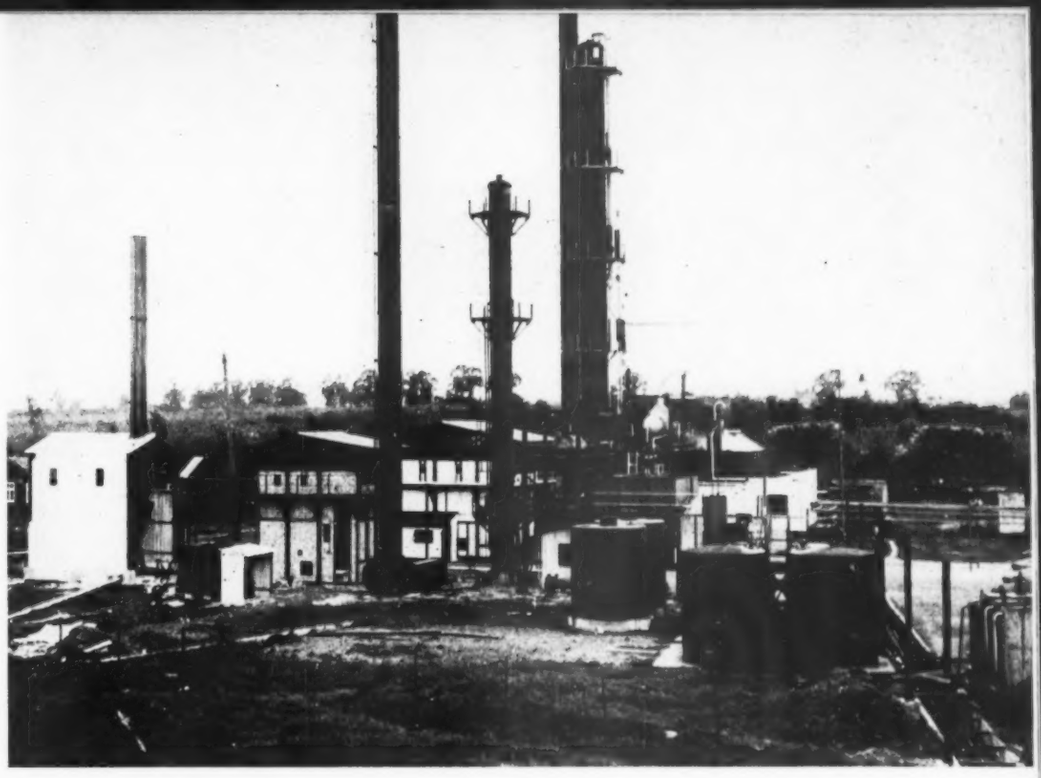
A 500 ft. pier has been built providing a deep-water berth on the outside, permitting tankers to moor at all states of the tide, with an inside berth for coastwise tankers. This pier is connected by an approach 1,700 ft. gantry, carrying pipelines and overhead ropeway.

The plant has a capacity of approximately 12,000 bbl. per day, and handles at the present moment three crudes: (a) heavy Mexican crude, (b) Venezuelan (Lago) crude, and (c) Peruvian high cold test crude.

Crude distillation units consist of in the case of (a) and (b) cylindrical stills in combination with pipestills with overhead bubble tower, fractionating equipment, condensers etc. In the case of (c) the cylindrical fire tube stills, bubble towers, vapour heat exchangers and residue heat exchangers are used.

Two cracking units of the modified Cross type, with a nominal capacity of 2,000 bbl. per day each, are in operation. The units consist of pipestills, reaction chambers, evaporator and bubble tower etc.

In addition there are continuous naphtha treating and sweetening plants, two agitators and one absorption plant. To this unit a stabilizing unit is being added, and now is in the course of construction.



The Kingsnorth refinery installation of Berry, Wiggins and Company, Ltd.

Other units consist of four cylindrical continuous and two vacuum batching asphalt stills for supplementing production and also manufacture of briquetting pitch, an acid recovery unit, a steel asphalt drum manufacturing plant, and a wood barrel-making plant.

The tankage consists of 119 tanks with a total capacity of 1,521,000 bbl. Utility services consist of boiler house and an electric generating plant.

The refinery is completely protected by salt water fire mains and some tanks are protected by foam lines connected outside fire walls to portable generators. Altogether 750 men are employed, most of whom live in the New Forest district and Southampton.

Two refineries are owned by Berry, Wiggins and Co., Ltd., a progressive undertaking which recently raised fresh

Part of the Ardrossan plant of Shell Refineries, Ltd.

Throughput of British Refineries

(Barrels)

	Crude	Refined and partly refined	Shale	Total
1929	13,100,000	3,900,000	1,200,000	20,200,000
1930	12,300,000	6,400,000	1,200,000	19,900,000
1931	10,400,000	6,600,000	1,000,000	18,000,000
1932	10,300,000	4,700,000	800,000	15,800,000
1933	11,500,000	3,300,000	800,000	15,600,000
1934	13,300,000	1,900,000	900,000	16,100,000

Retained Imports and Home Production of Petroleum Products

(Barrels)

	Retained Imports	Retained Home Production	Apparent Consumption	Percentage Home Production to Apparent Consumption
1931	42,105,000	12,191,000	54,296,000	22.3
1932	44,823,000	10,066,000	54,889,000	18.3
1933	51,360,000	8,877,000	60,237,000	14.7
1934	59,071,000	8,209,000	67,280,000	12.2

Drums and barrels for asphalt made at the Fawley refinery of Agwi in England.

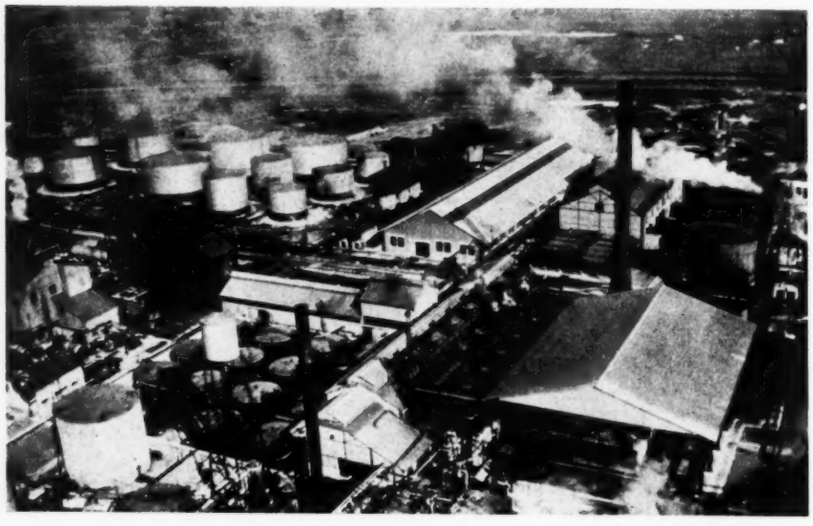
capital to develop its business. At Kingsnorth-on-the-Medway, Kent, equipment consists of a Foster Wheeler vacuum flash unit for bitumen and a Foster Wheeler atmospheric distillation unit to handle 1,500 bbl. topped or untopped crude daily, with a similar unit to handle 800 bbl. daily. This plant is engaged largely on production of refined lubricating oils, bitumen and bituminous materials. During the latter part of 1934 the second refining unit was completed. This unit follows the general lines of the unit previously in operation. It is of the single flash type and consists of tube still, fractionating tower, and the usual vapour condenser and coolers, heat exchangers and necessary run down tanks. The North of England refinery, owned by the company, at Weaste, near Manchester, has a plant similar to the larger of the Kingsnorth units, and produces a wide range of heavy oils and bitumens. A spirit flash unit is planned as an extension to the company's plant at this centre.

Operating under the new Irish Free State preference of 2d. per gallon on motor spirit, Cork Harbour Oil Wharves has established a refinery at Haulbowline Island, opposite Queenstown, Southern Ireland. With a daily capacity of crude of about 600 bbl., this plant consists of a Foster Wheeler distilling unit, capable of handling a wide variety of crudes. Gasoline is produced as an overhead vapour product, and white spirit, kerosene and gas oil are secured as side streams from the fractionating tower. Fuel oil is also included in the output. The operating company, which has its head office in London, is now controlled by Oil Wharves Limited; but Lobitos Oilfields and Anglo-Ecuadorian Oilfields have a considerable interest in The Cork Harbour Company, and crude for the refinery is being supplied from the Lobitos property in Peru.

Cory Brothers and Company Limited, operates a refinery at Corytown, Stanford-le-Hope, Essex, with deep water wharfage in the mouth of the Thames, within the boundary of the Port of London. Daily crude capacity of the plant is 6,000 bbl., the principal equipment including pipe stills, shell stills and steam stills, with a 2,000 bbl. cracking plant and storage tank capacity of approximately 1,750,000 bbl. A complete range of products, including motor spirit, kerosene, gas oil, Diesel oil, fuel oil and bitumen, can be turned out from this refinery, which is extended from time to time to keep pace with the expansion of the company's business. Headquarters of the company are at Cardiff, Wales.

With the opening a year ago of the Lobitos Oilfields Refinery on the Manchester Ship Canal, at Ellesmere Port, one of the most notable of recent British refining industry developments was completed. Apart from its significance for the British market in petroleum products, the entry of Lobitos into British refining had considerable importance, since it created another British integrated undertaking on lines similar to the Anglo-Iranian, Lobitos bringing a considerable proportion of its Peruvian production to Britain for refining. Designed to handle 2,200 bbl. of crude daily, the new Ellesmere refinery produces benzine, kerosene and gas oil from the atmospheric stage of its operations, thereby producing charging stock for the vacuum stage to yield a complete range of lubricating distillates. Engineering plans for the process were prepared by Alco Products Incorporated, of New York, in collaboration with Moore & George as consulting engineers. The atmospheric stage is an application and development of the Stratford oil-circulating type of distilling unit. It consists of vapour-crude heat exchangers, settling tank, Stratford oil circulation heater, vapourising tower, fractionating tower in three independent sections, reboilers and distillate receivers. Included in the vacuum stage is an Alco type still of modern design, providing a convection and radiant section and a bubble fractionating tower with stripping towers for each distillate. A full range of products is being turned out, and it is understood that special attention is being devoted to production of lubricating oils. The head office of Lobitos Oilfields is in London.

One of the most important plants in England: the Shell Haven refinery of Shell Refineries, Ltd.



Now nearing completion at East Halton, Lincs. is a large solvent plant, which is being erected for Herbert Green and Co. Ltd. by the Lummus Company of New York under Duo-sol license. It will have an annual capacity of 40,000 tons of lube oil.

Situated at Thames Haven, Essex, the big storage installation of London and Thames Haven Oil Wharves includes a refining plant of considerable importance. Total area of the site is 300 acres, with a water frontage of three miles, of which one mile is wharf. A complete topping plant forms the main refinery equipment, which is capable of a crude throughput of 20,000 bbl. a day, and employs 200 hands when fully occupied. London and Thames Haven does not act as a dealer or merchant, and the refinery plant is an adjunct to the facilities offered by the company for storage and handling of petroleum products. The refinery facilities are used mostly for the production and re-distillation of motor spirit, and for the production of kerosene, white spirit, gas oil and fuel oil. A subsidiary undertaking, British Bitumen Refineries, Limited has just completed a bitumen refinery at Thames Haven which is probably one of the finest in the country.

In connection with its distributing depots in Leeds, Sunderland and Newark, Major and Company Limited, an old-established concern operating in the north of England, has a refinery at Hull. The plant consists of continuous stills capable of dealing with approximately 1,200 bbl. of crude daily. It is constructed to the company's own patent, with batch stills and washers of both batch and continuous types. Motor spirits, special benzines, white spirits, kerosenes and special distillates, Diesel and gas oil are produced. The refinery has recently been re-distilling semi-refined products.

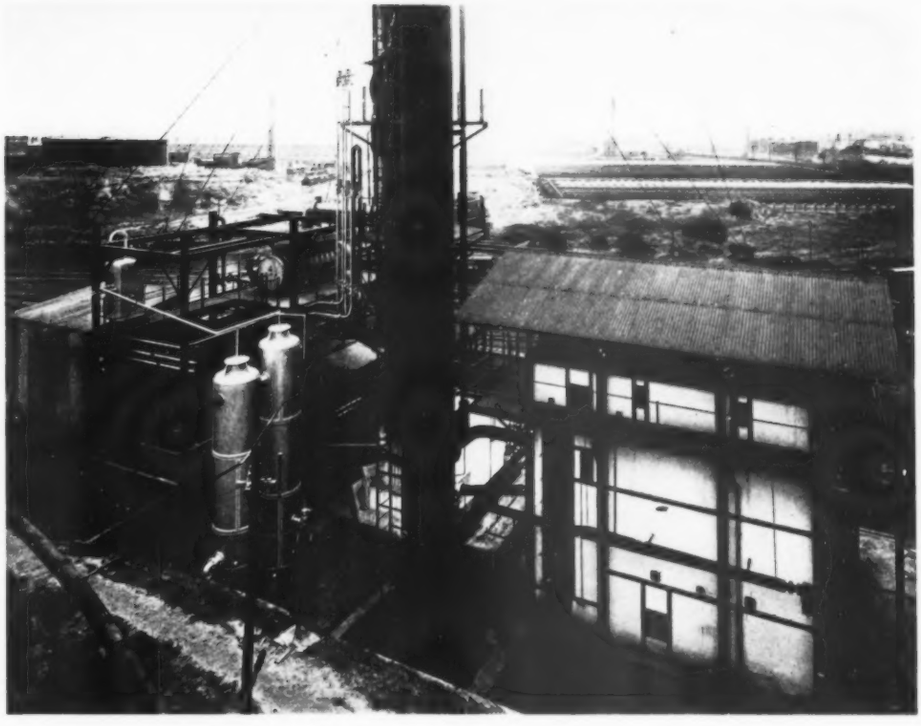
Medina Refinery Limited, of Deptford,

London, has a plant for the manufacture of all grades of lubricating greases, with blending pans fitted with compressed air and other mixing devices.

First among the modern refineries of Great Britain, both from the standpoint of date and importance, is the plant at Llandarcy, Wales, controlled by the Anglo-Iranian Oil Company through National Oil Refineries Limited. Construction of this plant was planned before the European War; but the work was only started in 1919, and completed in 1921. Total area of the works, including tank farms and model village for employees, is around 700 acres, and the plant gives employment to about 750 hands, including administrative and clerical staff. Crude capacity is in excess of 20,000 bbl. a day, and the cracking plant, comprising one Dubbs and three other units, has a capacity of 4,000 bbl. A relatively large part of the work of this refinery is the production of special spirits and solvents, specially treated burning oils, high quality lubricating oils and specification gas oils. The plant is subject to constant changes and additions, the most important development last year consisting of the installation of the latest distillation and fractionating equipment with the object of increasing efficiency in the output of lubes. National Oil Refineries has another plant of comparable size at Grangemouth, Scotland, where a larger proportion of the work consists of the production of motor spirit. Former shale oil plants at Oahbark, Pumpherston and Uphall, owned by Scottish Oils, another Anglo-Iranian subsidiary, are now engaged largely on petroleum.

National Oil Refineries' plant at Grangemouth, Scotland, has a capacity of approximately 7,500 bbl. a day. Of the total area of 700 acres owned by the company to the east of Grangemouth, 104 acres are occupied by the refinery, which employs 190 workers. Although the ground has a long frontage on the Forth, this is not used for berths for tankers, two tanker berths being maintained within Grangemouth Docks. Each berth is capable of accommodating a 450 ft. ship, with a constant depth of 30 ft. of water, irrespective of tides. These tanker berths are connected to the refinery by eight separate pipelines, each approximately 1½ miles long, and of 8 inch diameter. Tank accommodation at the refinery exceeds 1,100,000 bbl. Principal products manufactured at Grangemouth are motor spirit, solvents, kerosene, gas oil, high speed and marine Diesel oils, and fuel oil.

Pacific Wharf, West Ham, where Redline-Glico Limited has a storage installation, with one-third of a mile of water frontage, contains a small refining plant,



Berry Wiggins refinery at Weaste, England.

the principal equipment consisting of batch distillation units and efficient fractionating plant. Output last year was 317,000 bbl., the main products including motor spirit, lubricating oils and white spirit. The company has a total storage capacity at West Ham of 1,750,000 Imperial gals., with tank storage for 120,000 gals. of lubricating oil. Operations have been carried on there continuously since 1904, the company having been established many years previously as the "Gas Lighting Improvement Company," from which the trade name "Glico" is derived. It is now a unit of the Jersey Standard group. The head office of Redline-Glico is located in London.

Three important refineries are operated by the Royal Dutch-Shell Group in Britain, the operating company being Shell Refineries Ltd., of London. Principal among these plants is that at Shell Haven, situated in Essex on the north bank of the Thames in close proximity to London. The refinery has an area of 100 acres, and is enclosed by a sea wall. It has a daily crude capacity of 7,000 bbl., vacuum distillation plant being its main equipment. At the present time an important addition is being made, namely a Furfural solvent plant and dewaxing unit for the production of high grade lubricating oil. Total tank installation is over 2,500,000 bbl., and the works employ between 800 and 1,000 people. Principal products are industrial and road asphalts, lubricating oils, white spirit and industrial oils. A considerable part of the activities of this plant are also concerned with blending motor spirit and fuel oil to the company's standard qualities. The other two plants of Shell Refineries, Limited, are similar in type to that at Shell Haven, each including vacuum distillation units, and producing somewhat the same class of output. At Stanlow, Ellesmere Port, the daily capacity is 4,700 bbl., and at Ardrossan, Scotland, 4,000 bbl.

Vigzol Lubricants (I.F.S.) Ltd. operates a small oil refinery at Dublin, Irish Free State, devoted principally to the manufacture of lubricating oils.

Plans are now being made for the complete reconstruction of a lubricating-oil distillation plant at Deptford, London, which originally came into existence 70 years ago. This plant was partly destroyed by fire a few years ago, and as the assets of the former owners, Worringham and Co., have been taken over by J. English & Co. Ltd., who have formed a new company entitled Edward Worringham and Co., Ltd., the refinery will be reconstructed. Present storage capacity is about 140,000 bbl.

J. A. Briggs and Sons, a Scottish oil company built a Foster Wheeler combination atmospheric and vacuum unit in 1931 for asphalt production.

The most important and ambitious refinery in Britain arising from the "Oil from Coal" movement is the Billingham-on-Tees plant operated by a subsidiary of Imperial Chemical Industries, Limited, of Millbank, London. This plant has an output capacity of approximately 3,000,000 gallons of motor spirit a year, and operates by the hydrogenation of coal

and creosote. It has been built at a cost of £6,000,000 and is in part operation. Official opening is expected to take place shortly.

Coal and Iron Industries, Ltd., have within the last nine months erected a large plant at Seaham Harbour which will be in full production by the time this goes to press. It will convert about 500 tons of coal per day. The annual output is expected to be 4,000,000 gallons of motor spirit, 4,000,000 gallons of Diesel oil, as well as about 100,000 tons of smokeless fuel and many valuable by-products. It has already been decided to start construction on a duplicate of the present plant immediately.

Operations of Low Temperature Carbonisation Ltd. are now assuming some importance in the coal-oil industry, although the predecessors of the process were in a state of development for many years without reaching a profitable commercial stage. A plant at Barugh, Yorkshire, is operated by the company, consuming 250 tons of coal daily, and a subsidiary concern has a plant at Askern, near Doncaster, using 500 tons a day. The Coalite process is used, and the products include coal motor spirit, fuel oil and Diesel oil. Additional plant is being erected at Barugh for production of Diesel fuel especially suited to high-speed engines. The head office of the company is in London.

A relatively newcomer in the new industry, the National Coke and Oil Company Ltd., of London, has recently established two plants, one at Tipton, in the Birmingham district, and the other at Erith, London. Each of these units consumes 300 tons of mixture a day, the mixture consisting of 50 percent coal fines, 46½ percent oil (produced in the process) and 3½ percent creosote. The plants have been constructed to the company's own design by Horseley Bridge and Thomas Piggott, Ltd., and produce motor spirit of high octane rating and smokeless fuel. Operations of Tipton began some months ago, and preparations for initial working at Erith have been taking place within recent months. Further plants are planned at Manchester, Edinburgh and Glasgow.

The British Government is not only supporting production of synthetic oil products from coal by a large consumption in its various military departments and by the substantial rebates in taxes imposed on both heavy and light oil fuels, but is also delving into the actual manufacture of these products with a view to aiding commercial production, and improving on present methods of plant construction and operation. One of the foremost programmes of the Department of Scientific and Industrial Research is being carried out at the Fuel Research Station, Greenwich, and deals with the conversion of coal-tar to synthetic oil products. By hydrogenation of low temperature tar it is possible to produce 100 percent spirit, by volume, which varies from 75 to 87 in octane number according to the throughput of the first cycle, leaving no residue at the end of the second cycle.

The Research Station has also been investigating for some time the possibility of producing a suitable lubricating oil from coal.

As yet the cost of the process has not been discovered, inasmuch as the plant has not been in use long enough for maximum efficiency to be obtained; but work is intended to determine economics of commercial hydrogenation as applied to coal.

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France Rounds Out Construction Program

Completions and Extensions of Refinery Capacity During Past Year Give Nation Fourteen Thoroughly Modern Plants With Yearly Capacity of Over 6,000,000 Tons.

PROGRESS of the French program of refinery construction was described in detail by WORLD PETROLEUM in October 1934 and 1933. During the past year activity has been mainly in the completion and extension of plants previously under construction. The program of development is now practically completed, for the time being at least. It has resulted in giving France 14 ultra modern refineries with a capacity of over 6,000,000 tons per annum. A brief review of these plants with particular attention to additions and completions during the past year is the purpose of this article.

ONE OF the largest and the most important plants in France is the Raffinerie de Normandie near Le Havre. It belongs to the Compagnie Française de Raffinage (partly owned by the French government) and was created to refine crude oil imported from Iraq under the Treaty of San Remo, by the Compagnie Française des Pétroles.

When the Compagnie Française de Raffinage was founded the government guaranteed it the right to manufacture 25 percent of the products consumed by the French market, and a series of agreements with the large distributing companies in France, who have a share in the capital, assures an outlet for these products.

La Raffinerie de Normandie is designed to have an ultimate refining capacity of 1,500,000 tons a year. It can now treat 800,000 tons. It occupies a rectangular site of 100 hectares, parallel to the canal of Tancarville and the Estuary of the Seine.

Crude oil arriving by tankers from Iraq is pumped from the dock storage tanks through two pipe lines, of 8 in. and 10 in. respectively, to the refinery where it is predistillated, stabilised and undergoes chemical treatment by sodium plumbite; it is then returned to storage under pressure.

This plant is the first of its kind to be erected in France. It reduces considerably losses caused by the storage of crude oil and distilled gasolines and is especially useful in cases where crude with a high H_2S content was to be treated. It has a daily capacity of 2,800 metric tons and was designed by Foster Wheeler.

After predistillation crude is treated in two atmospheric distillation units designed by the Arthur G. McKee Co., hav-

ing a total capacity of 2,200 tons per day. Products obtained are the following: rectified aviation spirit, gasoline, white spirit, two different kerosenes, two different gasoils and a paraffine distillate which amounts to about 32 percent of the original Iraq crude. This residue is returned to the vacuum distillation plant where a heavy distillate for cracking is obtained and an asphaltic pitch. The unit, designed by the McKee Co., has a daily charging capacity of 750 tons.

The refinery possesses three cracking plants; two are of the classical type with a nominal capacity of 450 tons a day. They either treat residues from the atmospheric distillation plant or different distillates. The third unit was erected during 1935 and is used for reforming heavy gasoline and solvents. It has a charging capacity of 275 tons a day. All these units are provided with plants for stabilising gasoline which were designed by the M. W. Kellog Co.

Redistillation of cracked gasolines which have undergone the usual acid and plumbite treatments is done in a Foster Wheeler two stage distillation unit (atmospheric-vacuum), with a capacity of 600 tons a day.

Gasolines are refined in four continuous operation plants designed by the McKee Co. Each plant has a daily capacity of 7,000 tons. Two of these are employed for refining cracked gasolines by the acid and sodium plumbite treatment, the other two are employed for treating distilled gasolines and redistillated cracked gasolines with a plumbite solution.

In order to obtain kerosene and lubricating oils the Compagnie de Raffinage has installed an Edeleanu sulphuric acid refining plant with a daily capacity of 375 tons which can be increased to 500 tons should the necessity arise.

This year, during the course of the summer, a new dewaxing plant was erected in which 5,000 tons of solidified paraffine will be produced annually. The plant includes chillers, filter presses and several Alanmor sweating stoves erected after designs furnished by A. F. Craig & Co., Ltd.

The Normandie refinery also comprises a number of auxiliary plants such as those for the treatment of acid residues. It has more than 160 storage tanks with a total capacity of 2,268,000 bbl.

IN ADDITION to the Raffinerie de Normandie, the Compagnie Française de Raffinage owns a second refinery near Marseilles on the Etang de Berre. It is known as the Raffinerie de Provence and supplies products required by the oil market in the South of France. Building operations were commenced only in 1934 and although the refinery is working, it is not yet completed. Its actual capacity is 400,000 tons and the plant has been erected in view of an ultimate refining capacity of 800,000 tons.

The Provence refinery now consists of a combined Foster Wheeler distillation unit in which predistillation, atmospheric and vacuum distillation operations can be effectuated simultaneously or separately. The nominal capacity of these units amounts to 1,500 tons, 1,100 tons and 525 tons per day respectively. A stabilisation plant with a capacity of 144 tons per day is also included in this unit.

The cracking plant at the Raffinerie de Provence differs slightly from that of the Raffinerie de Normandie, inasmuch as it is a combined cracking and reforming unit with two heating cycles (circuits) erected according to the designs of the M. W. Kellogg Co.

Refining of cracked and distilled gasolines is effected in a McKee acid refining plant comprised of three units with a nominal capacity of 600 tons each. Kerosene is refined in a plant comprising two agitators where fuming sulphuric acid is employed. It has a capacity of 100 tons a day. Redistillation of cracked gasoline which has undergone acid treatment is effectuated in an atmospheric distillation and vacuum plant with a capacity of 600 tons a day.

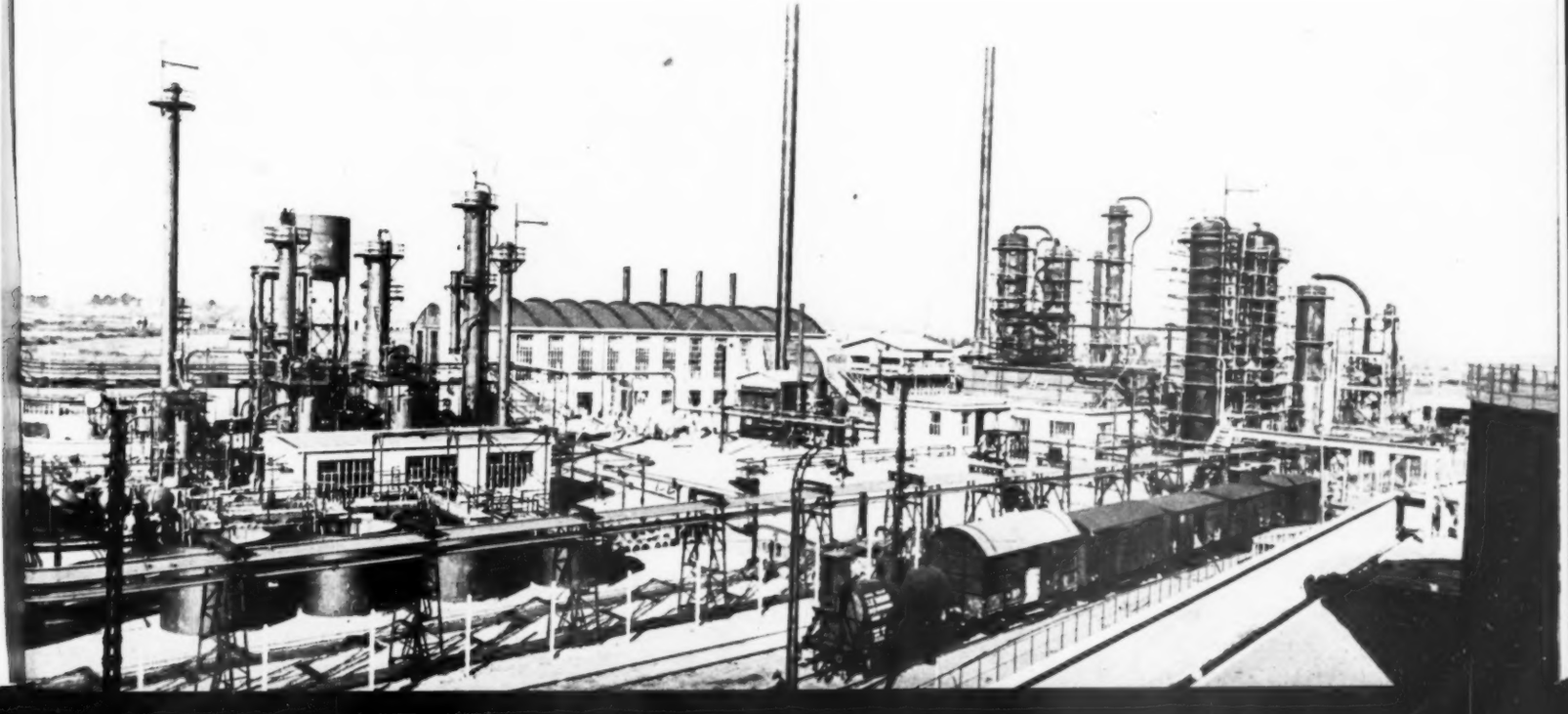
Raffinerie de Provence is well equipped with auxiliary installations and storage facilities, and the village which has been erected for the workmen and staff is one of the most attractive in France.

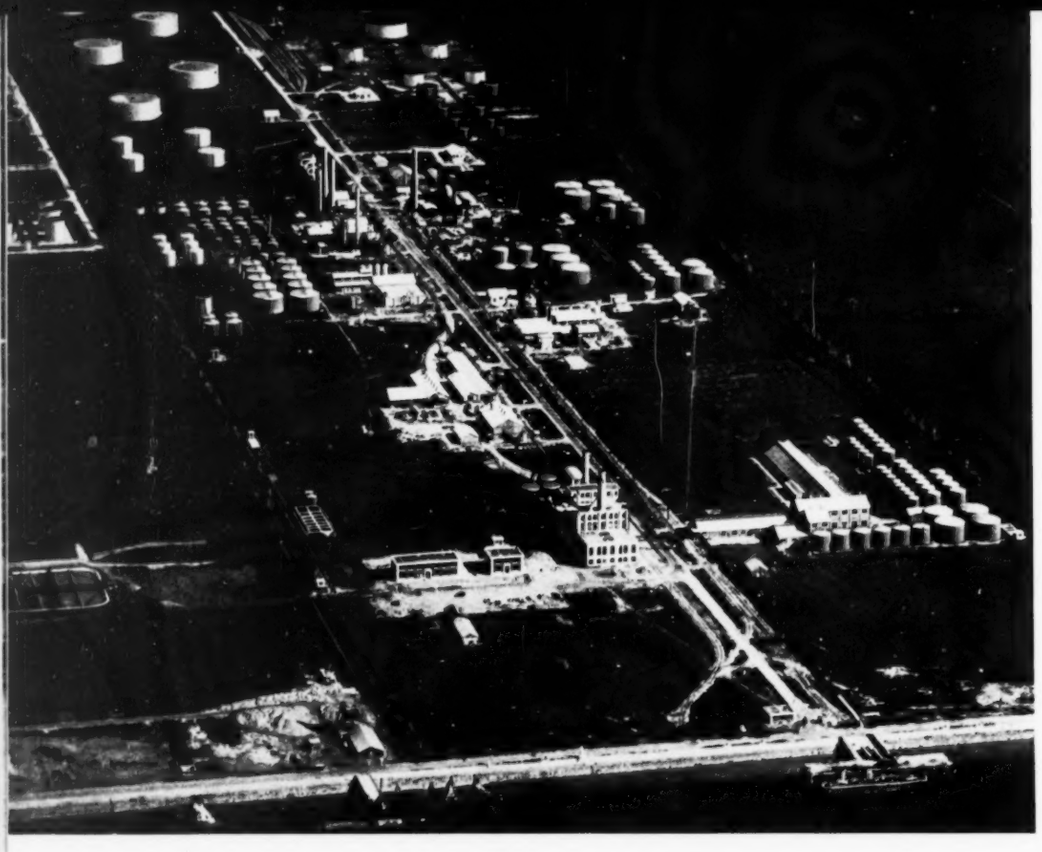
DISTRIBUTION of Royal Dutch Shell products here is taken care of by the S. A. des Petroles Jupiter owner of La Raffinerie de Petit Couronne in the North, near Rouen, and La Raffinerie de Pauillac in the Southwest, about 30 miles from Bordeaux.

Petit Couronne, the larger of the two refineries, consists of two separate plants built in 1927 and 1931 respectively (completed in 1929 and 1932). These plants were originally designed to treat crude oil from Venezuela and Netherland India. Their capacity amounted to 744,000 tons until certain modifications and additions were made in order to refine crude oil from Iraq. The refinery now has three separate distillation plants, a refining unit, a redistillation plant, a plant for treating asphalts. A Dubbs heavy oil cracking unit has been added recently and was put into operation in May 1935. It has a capacity of 570 metric tons (approximately 3,591 bbl. a day of topped Iraq crude). The unit operates on the Dubbs selective full flashing principle with light and heavy oil cracking coils. It is equipped with two Babcox and Wilcox furnaces, a reaction chamber, flash chamber, main fractionating column, second fractionating column, individual stabilizer and the usual complement of condensers, coolers, pumps and other equipment.

A Dubbs reforming unit with a capacity of 340 tons per day is now under construction for converting low octane number straight run gasoline into gasoline of higher octane number to meet market re-

Pechelbroun-Ouest.





Vacuum oil refinery in France.

quirements. It will consist of a furnace incorporating the most modern principles of controlling the cracking time in the cracking coil, a flash chamber, main fractionating column, secondary fractionating column, individual stabilizer, condensers, coolers, heat exchangers and pumps.

Refining of P.D. and R.D. is done with the usual sulphuric acid treatment at Petit Couronne, but the S. A. Jupiter plans to erect a plant for treatment with sodium plumbite. Centrifugal separators with an hourly capacity of 5,000 litres (1,321 U. S. gal.) have been erected for the continuous separation of acid tar.

Petit Couronne is equipped to produce every sort of product including butane, propane, lubricating oils and asphalts. Three different asphaltic residues are obtained from the vacuum distilling operations known as "Spramex" (viscous at ordinary temperatures), "Mexphaltes" (solid at ordinary temperatures) and hard pitch.

New plants for the treatment of gas from the cracking and refining units are also under construction at the present time.

Petit Couronne Storage Capacity

	Metric tons
Crude oil	120,000
Products in process of manufacture	30,000
Products	100,000

The annual refining capacity amounts to 420,000 to 480,000 tons and roughly 610 pairs of hands all told are employed at Petit Couronne.

Pauillac refinery, although built on a much smaller scale, is very similar to Petit Couronne, and is now in a stage of transition. It was originally designed in 1931, to treat 144,000 tons of Venezuelan and 180,000 tons of Netherland India crude oil per annum. However, a new Dubbs heavy oil cracking unit and a new reforming unit, identical to those at Petit Couronne, are now being added to the two existing distillation units which will allow the original charging stocks to be replaced by crude oil from Iraq.

The only difference worthy of mention between these two refineries is that Pauillac has an Edeleanu plant for refining kerosene and that the storage capacity is not so great.

STANDARD Franco Americain's refinery situated at Port Jerome, 3.5 miles from Lillebonne, between Le Havre and Rouen on the Seine, has been described in full detail by WORLD PETROLEUM. It will suffice therefore to remind the reader that it has a capacity of 1,000,000 tons, manufactures all products including liquefied gases for domestic uses, and has been equipped to treat crude oils of different origins. The distillation plant is composed of two units (two stage each). Total daily capacity varies from 24,000 to 30,000 bbl. according to the grade of crude run. Average throughout is about 24,000.

The cracking plant comprises three Tube and Tank cracking coils, each battery consisting of two towers. Unit No. 3 is equipped with intercondensers of the Leach type.

Heavy distillates are refined by the sulphuric acid method and are afterwards treated with a sodium solution together with other distillates.

Lubricating oils are refined with selective solvents and afterwards treated with activated clay.

There is a dewaxing plant consisting of six separators; the cooling plant is equipped with two stage ammonia-fed compressors driven by electric motors.

Redistillation batteries for distillates comprise pipe stills, plate columns, condensers, exchange pumps and accessories. The plant for treating recovery gas includes equipment for the absorption and recovery of hydrocarbons and a stabilising plant for gasoline. Butane is manufactured in this plant and work recently was begun on the erection of a new installation for manufacturing propane.

Port Jerome is one of the rare refineries in France where oils are treated with phenol. A plant for treating bitumen comprises one pumping station with four pumps, one oxidation column in which special bitumens are manufactured, and ten tanks with a capacity of 8,000 tons, also a special plant for manufacturing fluid bitumens which are used for the maintenance of roads.

There are eight large storage tanks for crude oil equipped with Wiggins floating roofs which have a capacity of 630,000 bbl., and a number of smaller ones for finished products with a total capacity of 567,000 bbl.

VACUUM Oil Co., S. A. F., has erected a refining plant on a site adjacent to that of the Standard Franco Americain. It is known as La Raffinerie de Notre Dame de Gravenchon. Building operations were commenced in 1931 and lasted two years. The distillation plant was put into operation in July 1933 and the cracking units in January 1934.

The refinery now comprises two Foster Wheeler two stage first distillation units with a daily capacity of 3,150 bbl. to 3,780 bbl. each. One combined cracking unit (type Kellogg-Cross) comprises three heaters, one reaction chamber and three distillation columns, with a total daily capacity of 2,520 bbl. No recovery plant for butane or propane has been installed at Gravenchon. Cracked gasoline is stabilised in the plant and the gas is used for heating.

Gasoline is refined according to type either by acid treatment or a plumbite solution. The acid treating plant has a daily capacity of 2,520 bbl. and the

plumbite solution plant a capacity of 3,150 bbl. to 3,780 bbl.

Redistillation of gasoline is combined with the cracking unit; the calories contained in the gas oil obtained in the unit are utilised for heating purposes. The different types of gasoline produced are then mixed in order to obtain products with market specifications.

Kerosene from first distillation operations undergoes chemical treatment which consists of (1) sulphuric acid treatment, (2) neutralisation of acid oils, (3) doctor treatment, (4) clarification. Daily treating capacity is 630 bbl. Oils obtained during the course of first distillation operations are refractionated in the redistillation unit, either by an atmospheric pressure or vacuum. This plant can deal with 1,102 bbl. in the first case and 945 bbl. in the second case. The different cuts of lubricating oils thus obtained undergo chemical and physical refining.

Chemical refining is done by means of concentrated sulphuric acid; all types of lubricating oils from the lightest to the heaviest cylinder oils are refined by Sharples continuous operating process and about 1,260 bbl. can be treated daily.

Filtration takes place in a plant consisting of two separate units, one for fluid oils, the other for viscous oils; together they have a capacity of 1,575 bbl. There are two dewaxing plants (one filter press and one centrifugal), with a daily capacity of 1,260 bbl. In both cases oils are chilled before being submitted to treatment. After having been filtered and dewaxed, the oil is returned to a Foster Wheeler distillation unit in which it is separated from the gasoline. This unit has a daily capacity of 1,260 bbl. It is then mixed and sent to the filling station where it is put in barrels and tins for shipment.

A new solvent treating plant designed by Max B. Miller & Co. for producing Clearosol lubricating oils is in course of erection at Gravenchon and will be completed shortly.

Crude storage capacity amounts to 481,950 bbl., and the total capacity of the 200 small and big tanks erected at this refinery for finished products is 1,323,000 bbl. An up to date laboratory in which 15 chemists and assistant chemists control all the products produced, is a guarantee of the quality of the oils put out from this plant.

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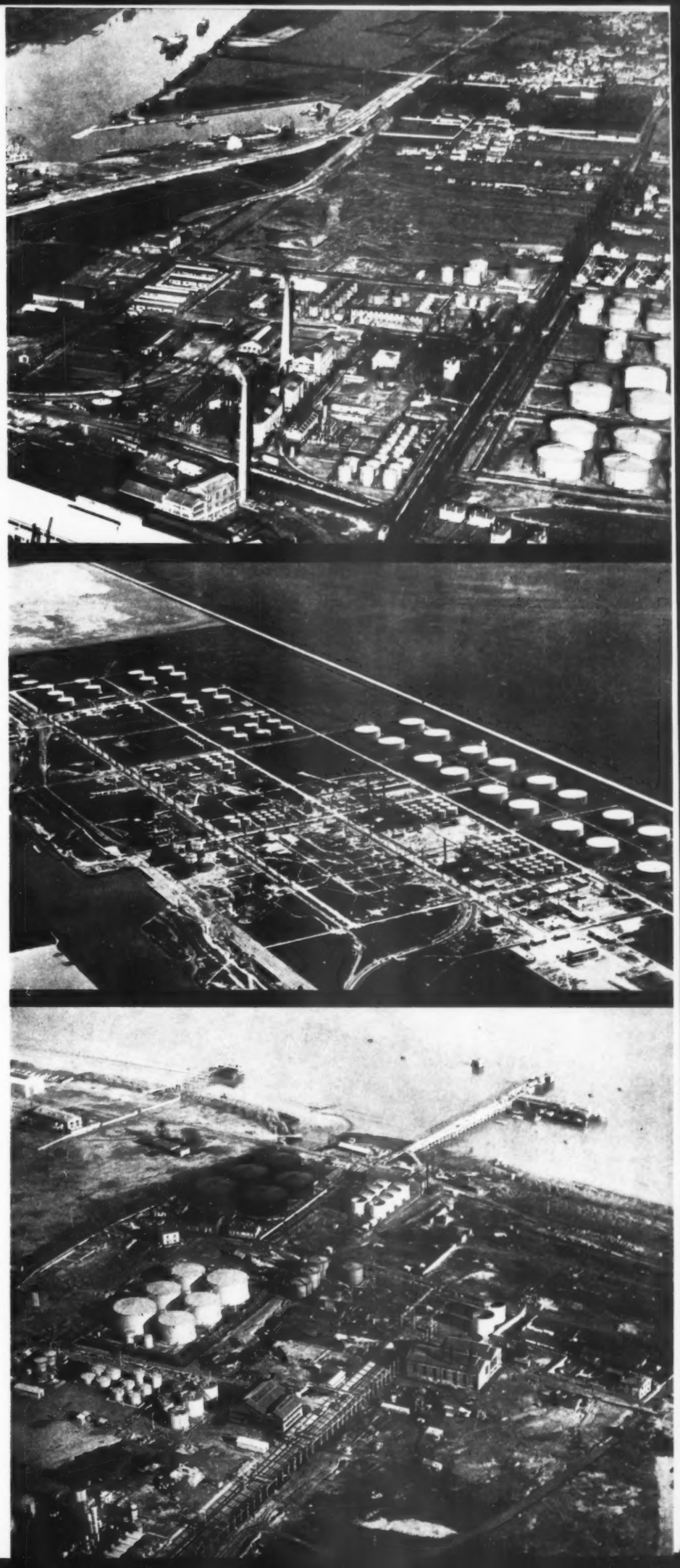

Three air views of French refineries: top, Petit Couronne before the erection of the new cracking units which are now completed on the land next to the plant shown in the picture; center, S. Française de Raffinage Raffinerie de Normandie: and bottom, the Pauillac refinery before the cracking units were added.

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Raffinerie de Berre.

A FEW minor alterations have been made in the Raffinerie de Frontignan, owned by the Compagnie Industrielle des Petroles, which is affiliated with the Vacuum Oil Co. It is equipped to treat 1,050,000 tons of crude oil a year. Refining operations were commenced at the end of 1932, when a first topping plant was completed, and cracking operations were started at the beginning of 1934.

The installation now consists of a first distillation plant erected by the Foster Wheeler Corporation, a Cross cracking and reforming unit, a two stage redistillation unit (atmospheric vacuum) and a debutinisation plant ordered in 1934 and put into operation in the beginning of 1935.

Different types of crude are treated at Frontignan but no lubricating oils or bitumens are produced there. Storage capacity for crude oil amounts to 201,600 bbl.; for finished products and those in process of manufacture storage capacity for 340,200 bbl. is provided.

THE Anglo Iranian Oil Co. is represented in France by the Societe Generale des Huiles de Petrole which owns two refineries, Courchelettes and Lavera.

Courchelettes dates back to 1865 and has been modernised several times. A vacuum refining unit, 1,750 bbl. capacity is now being added by Soc. Construction D'Affareils after Alco designs and should be completed in 1936. As it stands to-day, it can treat roughly 200,000 tons, covers an area of 150 acres and employs about 800 workmen. There are two first distillation plants to which one tube-still and one vacuum fractionating tower are being added. The topping plant has a nominal capacity of 700 tons a day while the integral refining plant produces about 70 tons of lubricating oils and paraffine. A selective solvent plant has been added and has just commenced operations.

In the beginning of 1936 a combined Cross cracking and reforming unit will be completed and a few months later a new topping plant will be put into operation. When this is done, Courchelettes will be equipped to produce gasoline, the usual products and a number of special products such as solvents, special oils and pitch.

At Lavera, refining operations were first started in 1933, and the plant is now working at maximum capacity, that is to say 8,000 bbl. of Iraq crude are refined every day. It takes exactly one week for the tankers to transport cargoes of crude from Haifa and Tripoli to Lavera.

In addition to the distillation units which were first installed, it now has a Cross cracking plant, and a new plant for the production of butane was erected recently.

ANOTHER refinery situated in the North of France is the Raffinerie de Dunkerque which belongs to the S. A. Raffinerie de Petrole du Nord. It covers an area of 42 hectares, treats American, Peruvian and Ecuadorian crudes and has an annual refining capacity of 550,000 tons.

It is equipped with one topping plant capable of treating 1,150 tons of charging stock daily, one combined atmospheric vacuum distillation plant with a daily capacity of 350 tons. It was designed especially to produce lubricating oils, and can be used as a topping plant. In the latter case it has a capacity of 650 tons. Two cracking plants with a total cracking capacity of 600 tons a day, one combined recovery and stabilising plant in which butane is manufactured; a continuous chemical refining plant with a daily capacity of 700 tons; a pressure distillate re-run plant consisting of a pipe still and fractionating column (daily capacity 200 tons); a chemical refining plant for oils (daily capacity 120 tons) and an asphalt manufacturing plant. Crude storage capacity at Dunkerque amounts to 359,000 bbl., while there are enough tanks to hold 567,000 bbl. of finished products.

THE Raffinerie de Pechelbronn, belonging to the S.A.E.M. Pechelbronn is the only plant in France where crude obtained from the national oil fields is refined. This amounts only to 78,000 tons per annum. Another 30,000 tons of Central American crude are imported to make up a total of about 110,000 tons.

Pechelbronn, which is situated near Strasbourg on the Rhine, is by no means easy to keep supplied with imported crudes; cargoes are discharged from tankers at Antwerp in Belgium. Thence they are transported by barge on the Rhine to Lauterbourg, where they are again transferred into tank wagons for further transportation to the refinery. The plant itself is not as up to date as other French refineries although it has been modernised from time to time. It is divided into three distinct sections:

(a) Lampertsloch, where national crude is topped, gasoline and oils are redistilled, refined, or cracked and white products and combustible fuels dispatched.

(b) Merkwiller, where lubricating oils obtained from topping of national crude are redistillated, all lubricating oils refined, coke and pitch redistillated and products other than the above mentioned, are shipped.

(c) "Kutzenhausen," where imported crudes are dealt with. This is the most modern section of the refinery.

Equipment at Pechelbronn consists of two topping plants for different crudes with a total capacity of 300 to 360 tons a day, one redistillation plant for white products which was erected a number of years ago, another for lubricating oils, one continuous refining plant for white products and a chemical treating plant for lubricating oils, one paraffine wax extracting plant equipped with filter presses, Sharples centrifugal pumps and sweating stoves.

In 1929, a Wolf-Carbürol cracking plant was erected in which gasoil (D.15= 0,850) serves as charging stock: 63 percent gasoline and 22 percent fuel oil are obtained, the remaining 15 percent being gas and losses. Bitumen and pitch are obtained by redistillation of topped residues.

Storage capacity is roughly 352,800 bbl., divided into 250 different tanks.

THE REFINERY of Pechelbronn-Ouest, a subsidiary of Pechelbronne S.A.E.M., is situated on the north bank of the Loire estuary at Donges (Loire Inferieure) about 15 kilometres (9¼ miles) from St. Nazaire.

It is laid out for the production, from imported crude oil, of various grades of gasoline, white spirit, kerosene, gas oil and fuel oil, and was constructed and erected under the supervision of Winkler-Koch and A. F. Craig & Co., Ltd.

The principal section of the refinery consists of a combined topping and cracking unit of Winkler-Koch type and design with a capacity of 4,500 bbl. of crude per day.

The raw cracked gasoline is treated in the vapor phase by the Lachman zinc chloride process.

The refinery also includes Winkler-Koch type gasoline recovery and stabilisation equipment and three separate sweetening units for treating the stabilised recovered gasoline, the straight run gasoline and the Lachman treated gasoline.

The last of these three units is seldom used since the Lachman treated gasoline at Donges is, in general, sweet and requires no further treatment.

The kerosene is treated in two agitators of the usual type, each having a capacity of 315 bbl.

A vacuum tower is provided for reducing the fuel oil or residue to asphalt.

The crude oil is delivered by tanker alongside a concrete jetty 700 metres (2,310 ft.) long and is pumped through a 12 in. pipeline to the main crude storage which has a total capacity of 226,800 bbl.

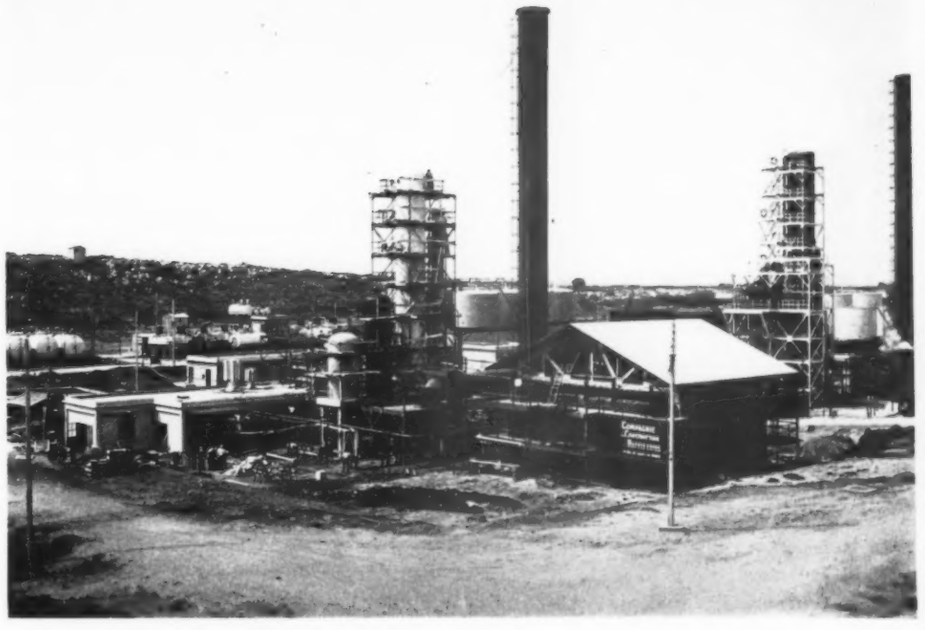
Make up condensing and cooling water is drawn from the Loire and is purified by means of aluminium sulphate in a special plant. Boiler feed water is drawn from a fresh water reservoir and from a low pressure distillation plant of S.C.A.M. type.

Steam at 15 kgs. pressure and 280 deg. C. superheat is supplied by four Walther type boilers, for driving the various pumps throughout the refinery, the exhaust steam from the pumps at 2.5 kgs. pressure passing to a Ljungstrom type turbine for generating electricity for refinery use.

The refinery is, of course, equipped with fire fighting apparatus.

Products are shipped from the refinery by tank barge, by railway tank cars and by road tank wagons.

THE OUTSKIRTS of Bordeaux are well provided with refineries. Jupiter was not the only oil company to choose that section as a site for its Pauillac plant.



Cracking unit at Havera belonging to S. Générale des Huiles de Petroles.

La Societe des Raffineries de Petroles de la Gironde which is now controlled by The Texas Company, selected a tongue of land known as Bec d'Ambes on the junction of the Garonne and Dordogne rivers, only 28 km. (17 miles) from Bordeaux, as a suitable place for the Raffinerie de Petrole de la Gironde.

It is equipped with a topping plant (capacity 6,300 bbl. a day), a Cross cracking unit (2,520 bbl. a day) and a Dubbs cracking unit of about the same capacity; a chemical refining plant, a rectification plant, a recovery plant for gas, a stabilising unit and all the necessary auxiliary plants.

Gironde has a total storage capacity of 118,000 tons.

COMPAGNIE des Produits Chimiques et Raffinerie de Berre refined 427,899 tons of crude in 1933, 521,851 tons in 1934 and will refine about 560,000 tons in 1935 if operations continue on the existing scale.

The Raffinerie de Berre occupies a site of 60 hectares (168 acres) on the Etang de Berre near Marseilles: it shares the markets of the South of France with the Raffinerie de Provence, Lavera and Frontignan. Building was commenced in 1929 and completed in 1931.

The refinery is equipped to treat crudes of all types and to produce a whole scale of products. A 12 in. pipeline 3 miles in length brings the crude up from the landing storage tanks to the refinery which consists of three topping plants (total daily capacity 1,500 tons), composed of one combined two stage Wilke unit (600 tons), one McKee No. 1 unit (400 tons) and one McKee No. 2 unit (500 tons), one continuous distillation battery (350 tons), one Cross cracking unit (2,500 bbls.).

White products, kerosene and lubricating oils are all refined by the usual methods.

Berre is equipped with a dewaxing plant which has an annual capacity of 4,000 tons approximately. Asphalt is produced in large quantities and arrangements have been made to allow for the filling of 1,000 bbl. of that product a day. Storage capacity is extensive, 325,080 bbl. having been provided for products in process of manufacture, and 40,950 bbl. for finished products; this will shortly be increased to 42,210 bbl.

FROM the foregoing it is apparent that France is now well equipped with refineries. She can meet all demands for products without difficulty, even should they increase with extreme rapidity. There is, however, one unrealized project which may be worthy of mention. I am referring to the Credit Minier Franco Roumain's petition for a license to build a refinery which has lain before the French authorities since 1930 and recently has been renewed.

If the C.M.F.R. obtains the desired permission, it will erect a plant capable of treating 200,000 tons of Roumanian crude per annun, consisting of a first distillation plant, a cracking unit and the necessary installations for the treatment of by-products (P.D., kerosene, ethylisation, etc.). Storage capacity to the extent of 100,000 tons is planned. Crude oil will be supplied by the Creditul Minier with which the C.M.F.R. is affiliated. Should other Roumanian companies decide to join in the enterprise, it is possible that ultimately this refinery will have a capacity of 400,000 tons.

E. J. ANDRÉ

Italy Plans for Added Refining Capacity

Program Anticipates Expansion of Domestic Manufacture with Gradual Elimination of Imports Except Crude and Fuel Oil — Permits Issued for Three New Plants.

WAR MEASURES, looking toward an Italian campaign in Ethiopia, have, at least temporarily, put a stop to the development of the Italian refinery program. Drastic measures affecting financial provisions both internally and as regards external exchange arrangements, coupled with the extremely high tax on motor fuel amounting to 58 U. S. cents per gallon, doubtless intended to conserve Italian petroleum supplies for the purposes of the Ethiopian campaign, have put an abrupt stop to active development and construction. It has been reported recently that no further construction of any sort will be authorized in Italy until the outcome of the Ethiopian affair is determined. Construction presently under way may, in some cases, be completed but no new construction may be undertaken. It may be assumed, however, that this delay is intended to be temporary and does not affect the fundamental aims of the Italian petroleum policy.

UNDER the laws passed in November, 1933, Italy adopted the policy of enlarging its petroleum refining industry. The regulations interpreting these laws were officially published in August, 1934. It is the intent to refine the crude oil necessary to supply the domestic demand for petroleum products within the country. To this end crude is admitted duty free whereas gasoline, kerosene and lubricants must pay duties of 120, 120 and 250 lire per ton respectively.

Italy's Annual Petroleum Requirements

Product	Tons
Gasoline	500,000
Kerosene	200,000
Gas oil	350,000
Lubricants	90,000
Fuel oil	1,000,000
Asphalts	80,000
Miscellaneous	20,000

If the proposed refineries were to satisfy all of these requirements it is obvious that upward of 2,000,000 tons of crude oil would have to be processed each year. Part of the fuel oil probably will continue to be imported, however, and the immediate program contemplates a refining capacity of 1,000,000 to 1,200,000 tons per annum, the exact amount being dependent upon the source of the crude oil. The laws prescribe the amount of products awarded to each refinery each year and supply and demand are thus coordinated.

Production of crude oil within the confines of Italy is very limited, amounting to but 19,942 tons for the year 1934. Consequently Italy must look outside her borders for a commensurate supply and to this end has been active in seeking new sources of crude over the past few years. The Azienda Generale Italiana Petroli, popularly known as AGIP, a government controlled organization, has been actively prospecting within the borders of Italy and now also has the controlling interest in S. A. Prahova of Roumania. More recently the AGIP has taken the controlling position in Mosul Oilfields, Ltd. and thus, in the future, will be actively engaged in the exploitation of Mesopotamian oil. A subsidiary of the Italian State Railways, namely the Azienda Italiana Petroli Albania, has extensive concessions in Albania. In accordance with the decrees, Italian refiners, upon request of the government, must use in part the crude oil produced by these agencies.

At the time of the initiation of the new oil régime there were three refineries in Italy. These were the ROMSA, owned by the AGIP, at Fiume; the plant of the Societa Italo-Americana del Petrolio, subsidiary of the Standard Oil Company of New Jersey, at Trieste; and that of the Societa Petrolifera Italiana, also a New Jersey Standard subsidiary, at Fornovo. The first named had a daily charging capacity of 2,500 bbl., while Trieste and Fornovo were able to run 1,500 and 1,000 bbl. respectively. In addition there were three cracking plants operating upon imported residuums. These were the DICSA, at Venice, now owned by AGIP; NAFTA, a Shell subsidiary at Spezia, and the BENIT at Naples. Control of the last named has now passed to the Socony-Vacuum Corporation. Each of these cracking plants consisted of two Dubbs units and charged 800 to 1,400 bbl. per day. Obviously a considerable expansion was in order to meet the demands of the Italian market.

Several issues of WORLD PETROLEUM last year dealt fully with the refinery construction programme, the policy of the Italian Government, and with the new laws and regulations. At the time it appeared probable that a large amount of construction would be under way by this time, but the working out of details and the difficult questions of petroleum import licenses occupied a greater period than was anticipated, while lately preparations for the Ethiopian campaign have absorbed much governmental and engineering attention.

In the year that has passed since the issuance of the decrees three definite permits have been granted for refinery expansion or construction. The names and locations of these undertakings are:

AGIP (Dicsa) plant, at Porto Marghera, Venice;
The Vacuum Oil Company (Benit), at Naples;
The "Aquila," at Trieste.

The AGIP at Port Marghera, under the technical management of Ing. Giorgio Calzavara, is installing a new pipe still for crude oil of 10,000 bbl. daily charging capacity. The contract for this unit has been placed with the Foster-Wheeler Corporation. Under the supervision of the Universal Oil Products Company the two present Dubbs cracking units are being remodeled and will have a daily charging capacity of 2,500 bbl. Two Italian steel fabricating companies; ILVA, Alti Forni E Acciaierie d'Italia, and Societa Italiana Ernesto Breda, have been awarded contracts for tankage which will more than triple the existing storage facilities at Porto Marghera. Further minor alterations and auxiliaries will be installed to bring this refinery to a balanced skimming and cracking operation.

The headquarters of the AGIP are at Via Gregoriana, Rome, but will soon be moved to the building now under erection at Via del Tritone, Rome. The former Minister of Communications, S. E. l'On. Prof. Umberto Puppini, is the new president. Ing. Oreste Jacobini is vice president and

technical director, assisted by March. Ing. Giovanni Patrizi. Conte Ettore Carafa d'Andria is general manager. Ing. Jacobini is also president of Azienda Italiana Petroli Albania (AIPA).

The permit granted to the Vacuum Oil Company S.A.I. will allow the production of 595,000 bbl. of gasoline and 135,000 bbl. of lubricants per annum, together with other resulting products. This indicates the construction of a complete refinery of 4,500 to 6,000 bbl. daily charging capacity. The plans contemplate crude distillation equipment, a solvent extraction plant, solvent dewaxing, a contact filtration plant, power and boiler house and all auxiliaries. As to cracking, it is still undecided whether to continue to operate the Dubbs units installed by the earlier BENIT organization or to build new equipment. The plans are being prepared and some inquiries have been sent to equipment and supply houses.

The president of BENIT is Nob. Comm. Enrico Parisi. The manager of the Vacuum Oil Company S.A.I. is Comm. Mario Petrucci. The work will come under the general direction of E. H. Atwood, refining engineer of the Vacuum's Paris office at 48, Rue de Courcelles. E. J. Seymour will be in direct charge of construction with offices at 226 Via Argine ai Granili, Napoli, assisted by J. K. Kelsey, technical adviser.

S. A. Aquila will build at Trieste a refinery for 1,750,000 bbl. of crude oil per annum. This figure represents 6,000 to 7,000 bbl. per day. The company includes Italian capital from Trieste and has foreign associates, among them French interests. A considerable portion of the products will be exported. Plans are in preparation and the work will start in the early fall. Borsig of Germany, in cooperation with the Foster-Wheeler Corporation, will undertake the design and construction of the pipe stills. Inquiries on other parts of the work are with the equipment builders.

Technical direction of this project is with Dr. Franz Kind of the Redeventza Oil Co., Rive de l'Escaux, Antwerp. H. E. Charleton will be in charge at Trieste, with Moore and George of London acting as consulting engineers.

Other pending projects which will be put under way as soon as the details are settled include:

Expansion of the AGIP refinery, either at Fiume or Porto Marghera, for the production of more lubricants. Dr. Felix Epstein is in charge of the Fiume plant and lubricating oil production and the direction is the same as for the other AGIP activities above.

The Societa Italo-Americana del Petrolio (SIAP) has announced no definite plans to date.

Expansion of the Spezia refinery or possible construction of a new plant by the NAFTA (Shell). No definite plans have been announced. The president of NAFTA is Senator Giovanni Attilio Pozzo. A. de Graan is managing director with headquarters at Palazzo Shell in Genoa.

There are other smaller projects which are seeking permits to share in the total quota. Among the most active are:

A proposed colonial skimming and cracking plant for Tripoli of 85,000 bbl. gasoline production per annum.

A refinery near Foggia for the possible special utilization of Albanian crude oil.

Other smaller companies that have in the past imported their supplies are interested in separate applications as well as possible consolidation of their manufacturing requirements.

In addition to these undertakings certain of the older established lubricating oil plants and specialty refineries will be modernized.

The question of permits for import of equipment is of special interest to refiners and equipment concerns at this time. Italian industrial concerns enjoy a substantial tariff protection. This, however, does not apply to free ports or to certain new undertakings which have a special dispensation in their concession. Permits must be obtained, however, for import of material and for export of funds upon anything brought into the country, whether destined for a free port or not. Such permits are granted sparingly and, as a consequence, many of the leading foreign equipment concerns have made arrangements to manufacture within Italy the greater portion of their requirements.

The administration of this program is directed by the Bureau of Corporations at Rome. Premier Mussolini is Minister of Corporations and S. E. L'On. Ferruccio Lantini is under-secretary. The active officials in charge are: Gr. Uff. Dott. Ernesto Santoro, general director of Industry and Comm. Dott. Alessandro Piazzoni, chief of the liquid fuel division. All questions of concessions are decided by a special committee of which the above officials and the representatives of the Finance, Interior and Public Works ministries and the Committee of Mobilization are members. Dott. Guido Parise is secretary. Permits are granted for the import of equipment and the export of funds by joint action of the Department of Finance, Sopranintendent to the Currency, Prof. Felice Guarneri, the Bureau of Corporations and the Associazione Nazionale Fascista Industriali Meccanici ed Affini of Milano. The director of ANIMA is Comm. Ing. Italo Locatelli.

The problem of import permits for the refining construction program is now being studied and simplified.

This program is well under way and is contemporaneous to a study by the State of all possible resolutions toward the development of the petroleum industry in harmony with present economic requirements. To this end it is intended to reduce taxes on automobiles. The first step in this direction was a reduction starting January 1, 1935, upon the annual car license fees. The annual fee after January 1, 1935, will be limited to that for a 30 h.p. car. The previous fees for large cars ran up to 7,000 lire or more per annum. At 30 h.p. maximum the fee will be 1,767 lire. Furthermore, with two cars under the same ownership it will be necessary, so long as only one is in use at one time, to pay only the license fee and insurance for the larger one. There is pending a further reduction which will amount to an average of 25 percent of all present license rates.

On the other hand the taxes on gasoline have been materially increased and the government is encouraging the production of alcohol and its use as a carburant as a means of assisting Italian agriculture. On August 26 a resolution was passed to transform all omnibuses for public and private passenger traffic to utilize wood gas. This change is to take effect by December 31, 1935. On August 30 the taxes on gasoline and kerosene were increased to 2,610 and 1,500 lire per ton respectively (approximately 58 cents per gallon for gasoline and 37 cents per gallon for kerosene). Increases on residuums also have been contemplated.

This extreme taxation may be considered as a transitory measure however and the large increase in the consumption of motor fuel during the first half of the year indicates the rapid progress that would be made in this direction with any sort of encouragement.

H. S. BELL

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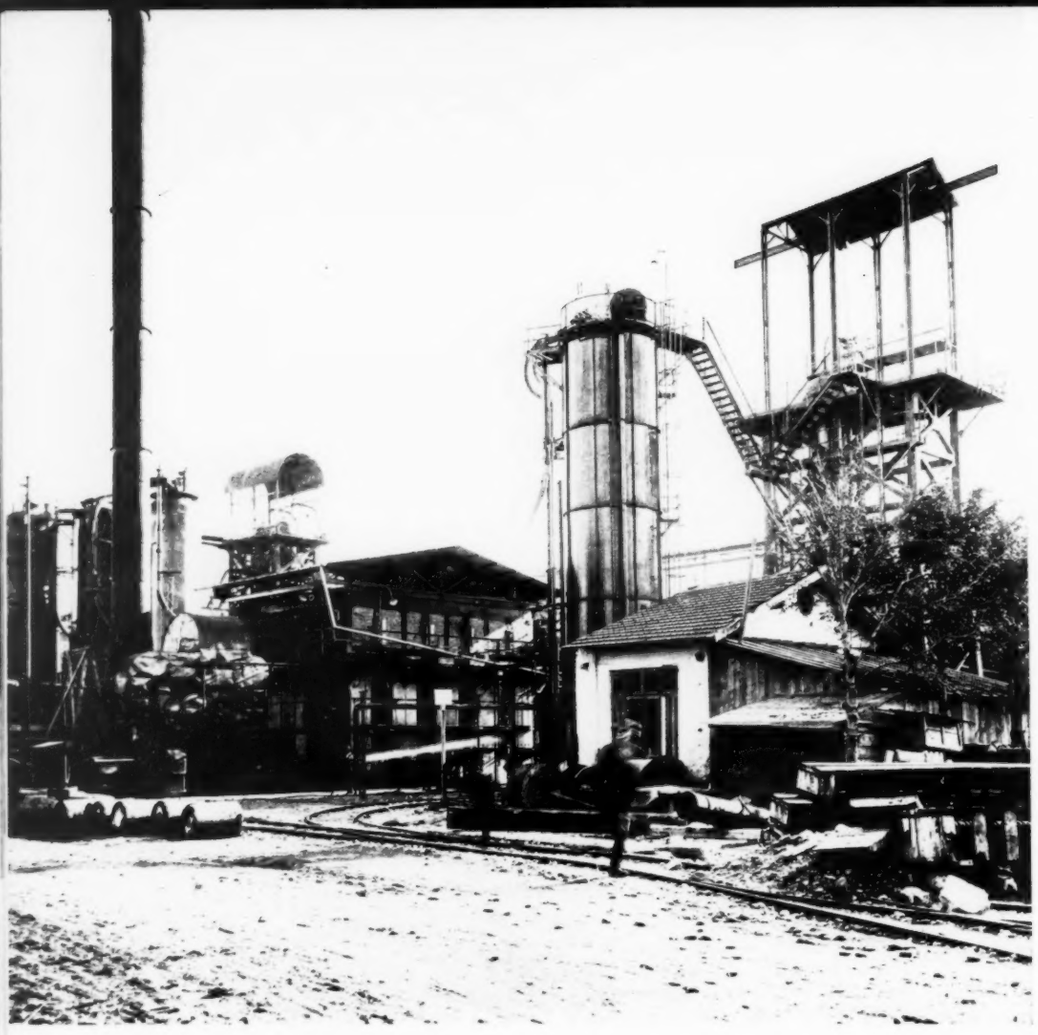
Venezuelan Shipments

DURING the month of June, Royal Dutch Shell interests shipped 4,587,920 bbl. of petroleum from Venezuela. Other shipments during this month were, Lago Petroleum Corporation, 3,834,324, Standard Oil Company of Venezuela, 2,569,654 bbl., Venezuela Gulf Oil Company, 1,303,491 bbl., and the Arend interests, 199,427 bbl., making total shipments from Venezuela during June, 12,494,816 bbl. The activity displayed by American petroleum interests in aquiring property in Venezuela, as indicated in our preceding issue, continued during the month of August, Standard of Venezuela, Venezuela Petroleum and Socony-Vacuum having acquired 274,693 hectares of new concessions.



Dubbs unit of the Steaua Romana refinery at Campina, Roumania.

Creditul Minier Adds New Plant to Roumanian Facilities

IN SPITE of the growth of refining costs, taxes and general expenses the Roumanian refineries have steadily improved their technical position. The cracking capacity of five principal companies has risen from 5,000,000 bbl. in 1932 to 10,800,000 bbl. in 1935. Nevertheless the critical situation that has existed in the Roumanian industry with the decline in prices that has taken place in the past few years has made it necessary to practice severe economics and to forego some improvements that otherwise would have been made.

In reality the decline in products prices during the past five years has been less on the average than the decline in crude so that the companies which engage in refining as well as production have fared somewhat better than those engaged in production only. Thus, in 1932, the mixed companies showed profits of 186,000,000 lei on a capital investment of 6,880,000,000 lei while the producing companies experienced a loss of 442,000,000 lei on a capital of 3,050,000,000 lei. While it may be argued, therefore, that the refining companies have fared better than those engaged solely in production the uncertainty that has prevailed in the international markets on which Roumania must depend for the sale of its products has not been conducive to the expansion of investments.

The outstanding addition to Roumania's refinery facilities has been the Creditul Minier Brazi-Prahova refinery, which is just beginning its work. It has been built with the help of Brunn Kralovo Poller, Maschinen u. Wagon Fabrik A. G., Czechoslovakia Astra-Arad, Ing. Tiberiu Eremie, Ing. E. Prager, Ing. Silviu Ciulley, Bucharest-Rumania. It cost 400,000,000 lei and has a daily through-put of 11,000 bbl. Its cracking capacity amounts to 1,760 bbl. daily. It has a pipe still topping plant, a kerosene refining plant, a doctor refining installation, a Dubbs unit for high anti-knock rating cracking, a power plant representing 3,000 kw., a boiler installation representing 1,050 square meters heating surface and giving steam at 35 atmospheres, reservoirs and tanks for crude, gas oil, fuel oil, kerosene, white spirit, gasoline, residues, cracked gasoline, debutanized gasoline, for 70,000 cubic meters. It has a filling installation for 50 rail tank cars at a time. With the addition of its facilities to those of the company's refinery Aurora-Baicoi it will increase the refining capacity of the Creditul Minier to 17,600 bbl. daily.

New additions to existing plants include a Winkler-Koch distillation unit of 6,000 bbl. daily capacity for the Ploesti refinery of the Colombia company which belongs to the Inter Omnium Petroleum group, a crude distillation pipe still of 8,400 bbl. daily capacity for the Concordia-Vega refinery at Ploesti and a carbo union gasoline plant for Astra Romana.

Among other improvements scheduled for 1936 are a new 1,700 ton pipe still, a new absorption plant and an enlargement of cracking coils for the Ploesti-Teleajen refinery of Romano-Americana, subsidiary of Standard Oil Company (New Jersey). Steaua Romana also will make important additions including two Braun units for cracking, a reforming unit for white spirit and gasoline and a McKee pipe still for lubricating oil.

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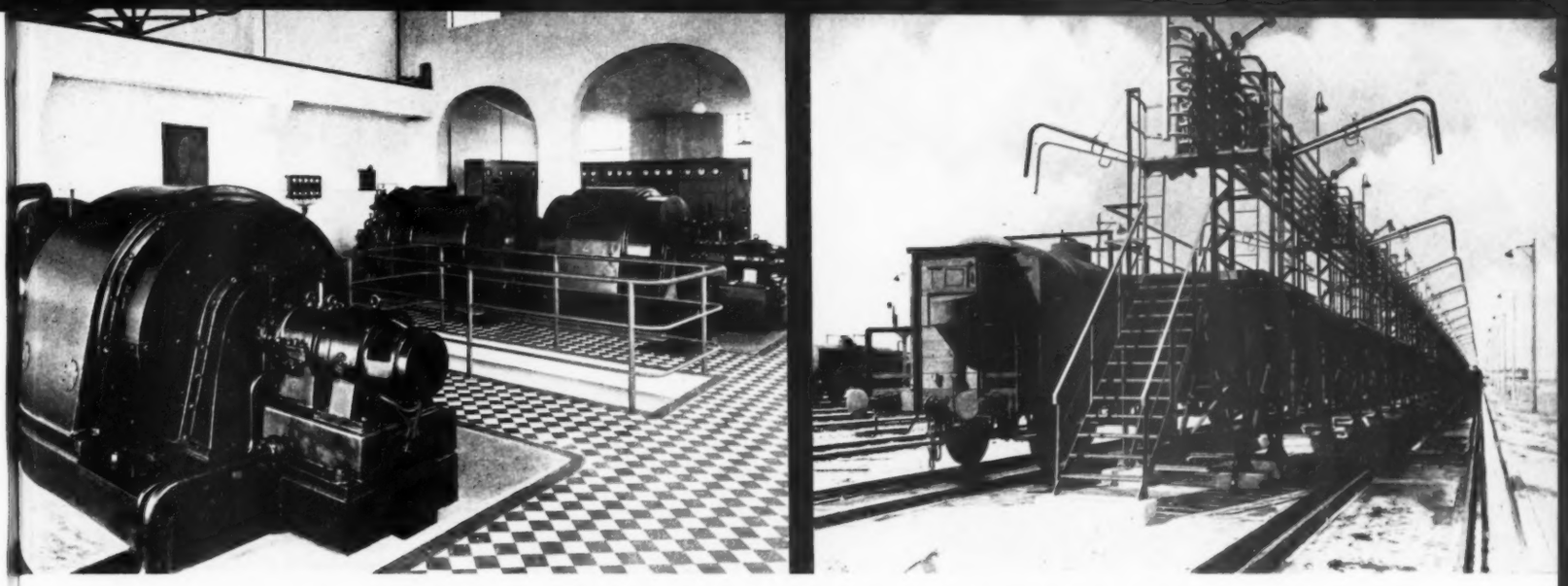
British Oil Imports

BRITISH oil imports continue to increase, showing a 4.5 percent improvement during the first eight months of 1935 compared with the same period in 1934.

(Barrels)

	August	8 Months to August 31, 1935	8 Months to August 31, 1934
Lamp oil	301,629	3,340,829	4,086,739
Motor spirit	3,325,112	24,944,454	22,027,343
Lubricating oil	249,316	1,962,890	2,124,972
Gas oil	133,457	1,904,228	2,732,829
Fuel oil	1,935,714	13,061,970	11,886,885
Other sorts	13,943	307,915	417,343
Total products	5,959,171	45,522,286	43,276,111
Crude	1,303,343	9,667,371	9,544,743
Total imports	7,262,514	55,189,657	52,820,854



Power plant with 3,000 kw. turbo generators, and loading rack for tank cars at the new Brazi-Prahova refinery of Creditul Minier

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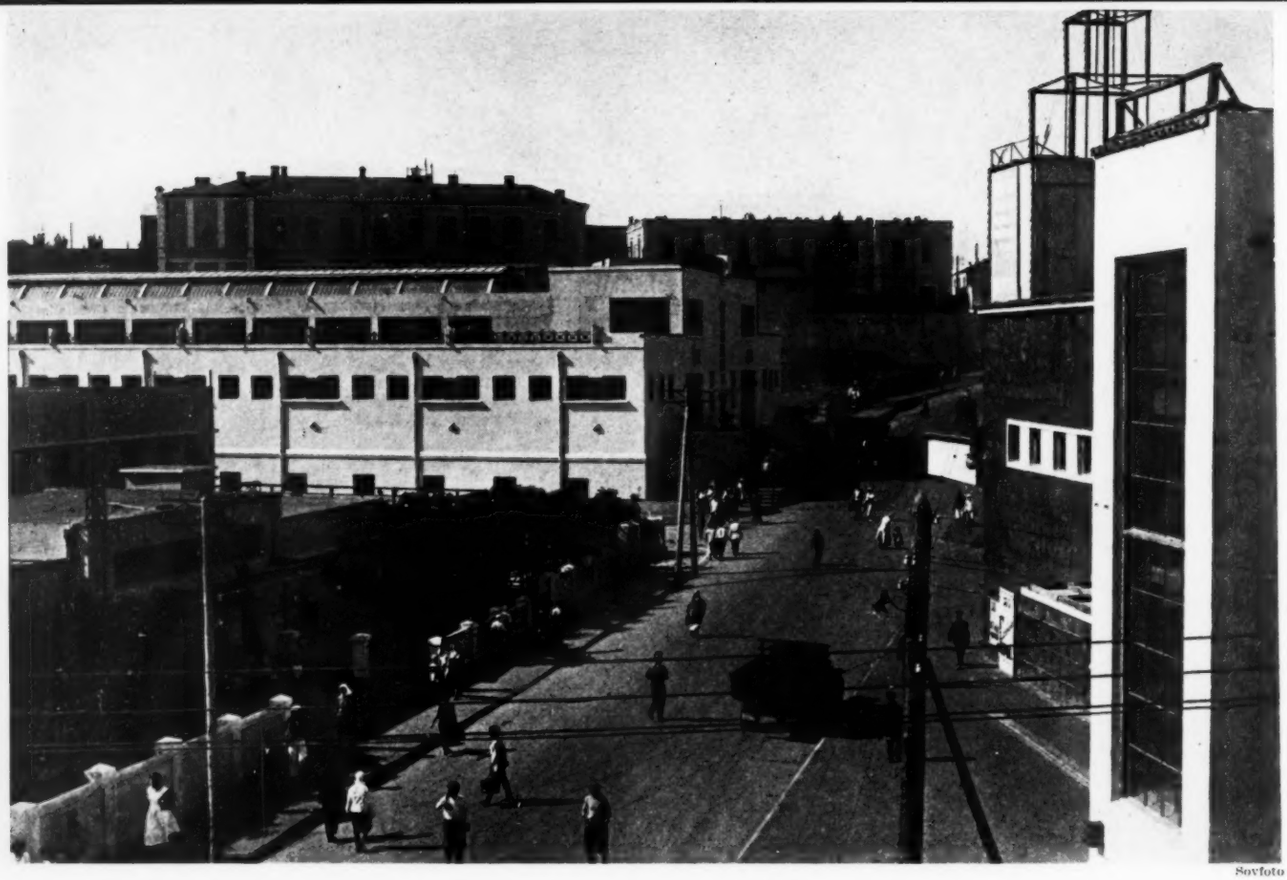


Sovfoto

A portion of the new Baku in the center of the workers settlement in the Lenin group of oil fields.

Soviet Refining Policy

Several Modifications of Soviet Refining Policy Have Occurred Since 1927; but Progress in Increasing Quality and Yields is Apparent.

By J. Wegrin

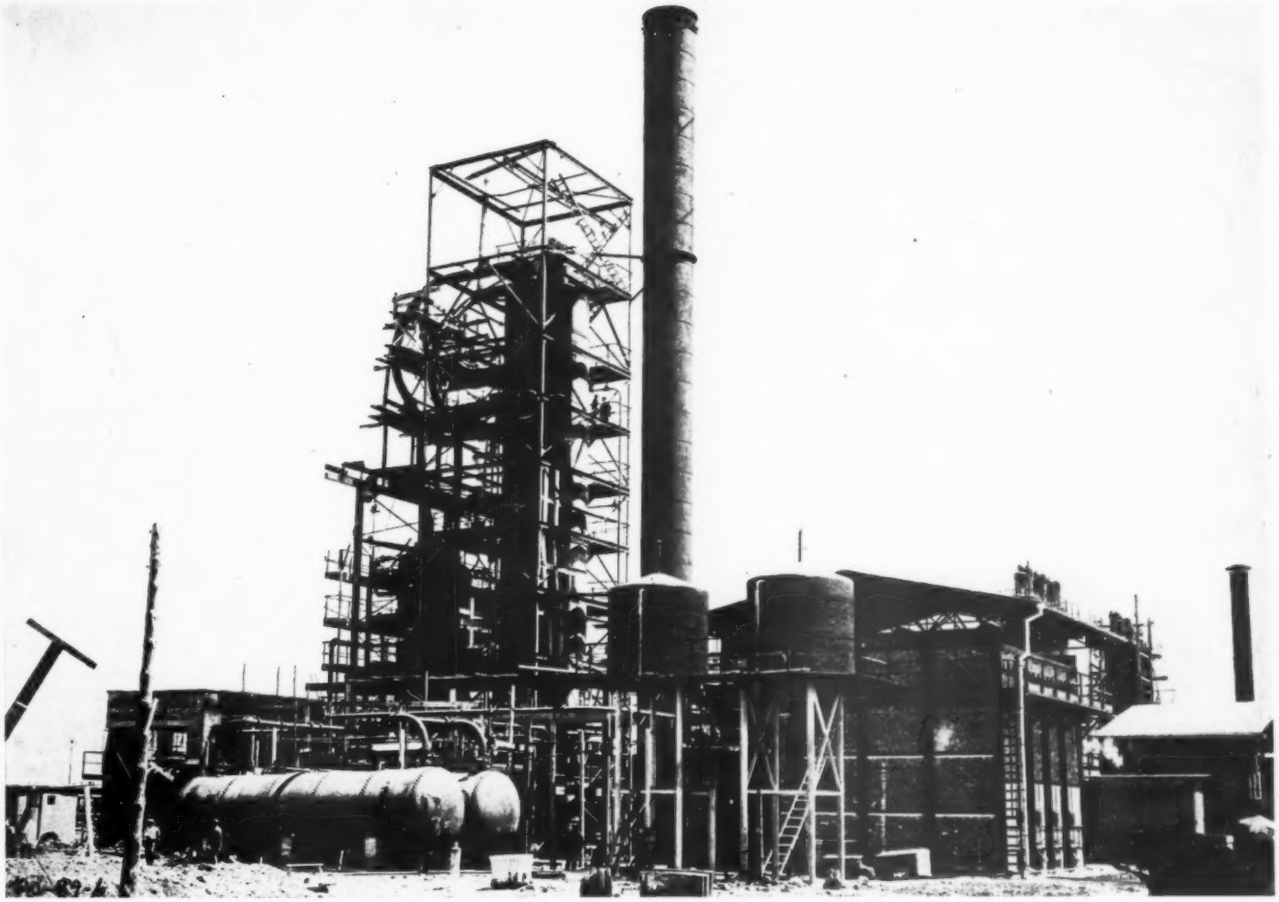
PRIOR TO 1927 Soviet refining facilities (at Baku, Grozni and Krasnodar) totaled 16 batch type shell stills with an annual capacity of 8,300,000 tons. Other small installations at Moscow, Odessa and Leningrad accounted for an additional 500,000 tons annual capacity. The building of modern refining facilities was undertaken at this time and the following plant capacities were erected: 1929—5,900,000 tons; 1930—3,950,000 tons; 1931—3,050,000 tons; 1932—1,100,000 tons; 1933—none; 1934—500,000 tons. Additional units to be completed by the end of 1935 include two cracking units at Grozni, six cracking units at Saratoff, one cracking unit at Khabarovsk and two cracking units at Baku. A complete, up to date record of Soviet refining facilities will be found on other pages of this issue under PETROLEUM REFINERIES OF THE WORLD.

Earlier this year a contract was signed calling for construction of a two stage vapor phase cracking unit at Sterlitamak, Russia by Alco Products, Inc. It will have a capacity of 12,000 bbl. per day for the production of aviation gasoline, motor gasoline, cracked fuel oil and asphalt. The plant consists basically of a two stage atmospheric and vacuum distillation unit reducing the entire charge to an uncracked penetration asphalt. The entire overhead products, consisting of straight run gasoline and gas oil cracking stock, will be charged to a two stage vapor phase cracking unit reforming the straight run gasoline and cracking the gas oil for a high yield of cracked gasoline. The entire gasoline distillate will be separated into aviation and motor gasoline dependent upon the desired endpoint and octane with independent stabilization for vapor pressure specifications.

The flexibility of design that allows the various units to be operated independently, provides a wide latitude for meeting variable operating conditions and marketing requirements or for processing different grades of crude petroleum.

Domestic Machine Shops

SOVIET domestic machine shops engaged in building refinery equipment are Red Hammer plant at Grozni, Kiroff Works at Gorlovka, Stalin Works at Baku, Montina Works at Baku, Leut. Shmidt Works at Baku, Miner Light Works at Baku, Novoye Sormovo Works, Taganrog Works and Podolski Works. According to Lomoff, Barinoff and other key men of the Soviet industries, the domestic output of equipment is still of poor quality, costly and requires more time than is necessary when the equipment is ordered from abroad. It is evident that the necessary reconstruction of the Soviet oil industry would proceed more successfully if the Soviets were in a position to accept assistance from abroad. Orders, of course, are being placed in the United States for



A modern distillation unit at Grozni, U. S. S. R., treating Baku and Grozni crude.

equipment and, in some cases, machinery, but the amount is small. For example, the estimated cost of the Saratoff units is about 80,000,000 rubles, while orders placed abroad amounted to only 1,000,000 rubles. These orders, moreover, were for controlling, measuring and registering instruments, as domestic precision instruments are not of the best quality.

Glavgormash is the authority under which all machine shops engaged in the building of oil equipment are coordinated. As has been already mentioned, design, construction and cost of output leave much to be desired. These shortcomings, however, are not necessarily due to poor equipment in the machine shops themselves, but rather to lack of proper working materials. The steel obtainable is of inferior quality, and the quantity is insufficient.

Evaporating or rectifying towers built from undersized sheets require more riveting or welding, and when the welding is poor, as is often the case, the efficiency and durability of the tower are directly affected. Tower bottoms patched or riveted together from scrap metal are bound to cause trouble.

Designs and working drawings of Neftproject generally lack uniformity. There are no fixed standards, and identical equipment or fixtures designed to operate under the same conditions of pressure and temperature will sometimes be riveted and other times welded. The net result is waste, high cost, inefficiency and lack of uniform results when these units are used interchangeably. Welding is cheaper and insures durability, but none of the domestic machine shops have adequate facilities for tempering welded ends, which accounts for the low quality. Welding sheet metal 1½ in. thick requires X-ray apparatus or radium emanation for guiding, but neither is available. Drawings are poor and need corrections, but Neftproject has no personnel free to do this work.

Glavgormash, having no offices on construction sites, has no facilities for making the drawings for such important objects as rectifying towers to operate under 12–14 atms. pressure or 45 ft. pipes of ¾ in. gauge. The Voti Works complain of lack of adequate alloys for thermo-vapor or heat pipes. The Saratoff cracking installations show poor operating efficiency owing to lack of adequate measuring, registering and controlling instruments. The Pyrometer Instrument Works of Leningrad are engaged in manufacturing instruments but they are unfit for responsible operation.

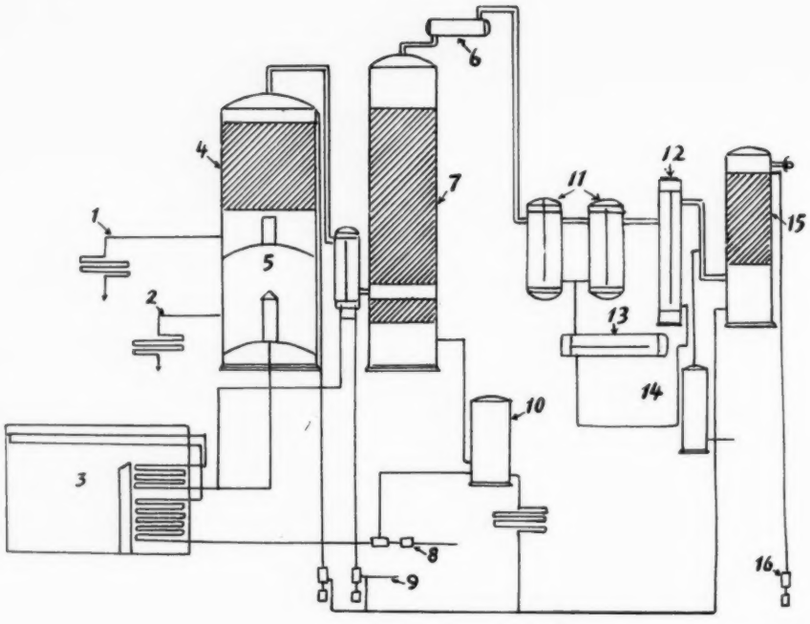
Return bends for cracking or pipe stills are being made with success at Sormovo, Montine Works (Baku) and other machine shops of Glavarmalit.

It would, of course, be inaccurate to say that there has been no improvement, but the improvement is a slow process.

Soviet Hydrogenation

As in countries that have no oil resources of their own, hydrogenation is of paramount importance in regions of the Soviet Union such as Siberia, where coal is plentiful and the hydrogenation of coal or shale would eliminate transportation of oil from the distant sources in the Caucasus. Soviet research has acquired sufficient data to warrant the erection of a semi-industrial installation at Kwmmerovo with a capacity of 10,000 tons of gasoline per day. This plant is expected to start operation early in 1936 and will serve as the basis of an experiment to determine the feasibility of building an industrial hydrogenation plant at a later date. Siberian semi-coking coal and coal from Barsaask (Kuznetzk basin) will be used. Both grades are known for tar and fuel yield, but it has not been decided as yet what methods will be used for enriching or concentrating the same.

The Siberian hydrogenation plant has been designed for two phase operation. Under 200–220 atm. pressure and a temperature of 400–450 deg. C. coal will be liquefied with hydrogen and converted into oil. At 500–550 deg. C. and under



Vapor phase, Soviet cracking design:

1. and 2. are coolers, 3. is the furnace, 4. the distillation tower, 5. the evaporator, 6. partial condenser, 7. rectification tower, 8. hot oil pump, 9. input, 10. gas oil tank, 11. condensers, 12. and 13. coolers, 14. separator and 15. absorber.

the same pressure but with a different catalyst, the oil will be converted into gasoline hydrocarbons. The catalyst which will be used will perform the operation with either gasoline, kerosene or lubeoil.

Crushed and dried coal, mixed with some oil or tar preheated by means of heat exchange supplied by the products from reaction, is carried to a pipe still where hydrogen is admixed to prevent coking or burning. The heated coal and oil forms a paste, which together with hydrogen, reaches a reaction chamber where oil is formed. The product from the reaction chamber, a mixture of gas and vapor, is taken from the top of the tower to a cooler, and then to gas separators where the gas is separated from the liquid. The gases, which are a non-reacted surplus of hydrogen, are carried to scrubbers for the removal of all harmful contents and are returned clean for further processing. The liquid under reduced pressure is rectified and carried to the second phase of the process, which is practically the same as the first phase, except the oil is there converted into gasoline. The hydrogen is compressed to 200 atm. before it is brought into the system for circulation.

This process of Soviet hydrogenation, though believed practical, is fraught with difficulties from the point of view of Soviet domestic machine shops, nor is the preparation of the coal and oil paste clear as yet. Crushing coal for use in electrical power plants is common practice in Soviet Russia, but carrying the material by power pumps under high temperature and high pressure, or physical properties of the material under the given heat transfer at prevailing conditions are still problems to be solved. Also reaction chambers over 200 atm. pressure and temperatures of 350 deg. and 500–600 deg. C. are still unknown to Soviet practice. Furthermore, two towers weighing 150 tons each requiring non-corrosive material costing about 1,000,000 rubles each will amount to an excessive sum.

The furnaces will be cracking furnaces of high quality, the erection of which is also still problematical. The supply of hydrogen is another task. The estimated requirements are 1/20 of the weighted quantities of the input of coal and tar. Such quantities of hydrogen will require six compressors of 10,000 cu. meters capacity per hour under 200 atm. pressure, and all necessary valves, reduction fixtures, etc. are as yet unknown to Soviet domestic shops.

The cost of the hydrogenation plant, excepting auxiliaries and housing facilities, is estimated at 300,000,000 rubles.

NEFTPROJECT has recently improved Soviet cracking practice and is now obtaining about 55 percent gasoline as against the previous 30 percent. In making these improvements practically all the new ideas of American refiners have been adopted with the exception of two phases, namely: increasing the pressure to 13 atm., making gas absorption unnecessary and increasing at the same time the temperature of the charging stock at the entrance of the furnace, (Neftproject has increased the pressure to only 6 atm. as there is little likelihood of the Soviet operators mastering the new cracking technique in the near future) while the second point of American practice not taken into consideration by Neftproject lies in the addition of reaction chambers (without liquid level) for thermopolymerization of the vapors. Soviet technologists have made studies of the use of reaction chambers while on visits to the U. S. and have found that while they are bound to increase the gasoline yield about ½ percent, their superiority in liquid cracking is still doubtful. Reaction chambers are at present under study by Neftproject and will be added if the results are considered favorable.

The two-furnace cracking process of Neftproject operates as follows. The charging stock sent through liquid heat exchangers is flashed to condensers and arrives at the first tower. The charging stock is then mixed with the heated residue from the bottom of the evaporating tower and carried by hot oil pumps to the light cracking furnace. A part of the residue from the bottom of the second tower is taken by hot oil pumps to the second furnace (heavier cracking stock) and the other part passes through a stabilizing deboiler, the charging stock preheater serving as a screening for the first tower. A part of this residue passing the heat exchangers is cooled and brought to an absorber and concentrator. The enriched stock is then returned to the towers and cracked. The products of cracking from both furnaces are mixed, and together with the cracking stock they come into an evaporator and thence to the first and second towers.

Neftproject two-furnace cracking yields gasoline of 70 octane rating with 520 mm. vapor pressure. The need for erecting 32 cracking units in a comparatively short time necessitates accepting these new introductions as satisfactory. Neftproject is designing more effective cracking systems, however, to operate under greatly perfected equipment.

MR. ALEXEEFF, chief engineer of the refining division of Glavneft states that during June two cracking installations of 500,000 tons capacity per annum each have begun operation at Saratoff. Two more cracking units of a similar capacity were completed at Grozni for liquid phase cracking. These cracking installations are of the Winkler Koch type modified only by addition of reducing facilities which were designed to improve the gasoline by increasing the octane rating. The Baku refining trust in conjunction with Neftproject has completed experiments covering the design and construction of two furnace cracking installations of 900,000 tons capacity which are scheduled to come on stream at the end of 1935. These installations will have reducing as a

main feature and the experiments have shown that they will yield about 37.5 percent of gasoline instead of 26 percent obtained from the old installations.

Some reconstruction has been undertaken recently at Baku and Grozni to improve the yield of kerosene from the old shell stills. The Baku shell stills yield about 55–60 percent of kerosene from the crude potential while the new refineries yield 90 percent. Tests were made with secondary rerun of the gasoil fraction by which 65 percent more kerosene has been obtained and it is very likely that all other refineries at Baku and Grozni will follow this practice. All new refining installations at Baku and Grozni produce kerosene of 572 deg. F. end point instead of 600 deg. F. as before. The higher boiling fractions from the kerosene are cut and returned to the ligroin cut.

Selective treating of lubeoil, until recently in the experimental stage at Soviet laboratories, will be introduced in practice. At Neftgas plant (Moscow), the Ziatim (Central Institute for Aviation Fuel and Lubeoil) has experimented with selective treating of lubeoil on a semi-industrial scale, with nitrobenzol used as reagent. Similar tests were made at the Budenni refineries of Baku (War dept.) and a testing plant has been erected for the chemical processing of pyrolise gases for production of ethyl alcohol, which is the raw material for synthetic rubber. At the Neftgas plant of Leningrad tests were made by treating cracked gasoline under pressure or light hydrogenation. The result was high stabilization and higher octane rating.

IN PREVIOUS NOTES on current building plans we have discussed the expansive program of new refinery building to be undertaken by Neftzavodstroi at Baku. Five pipe stills and four solaroil cracking units will be erected within the area of Cherni gorod (Black town) and Beli gorod (White town) between the existing refineries and their operation coordinated with the existing plants. In order to procure space for these units, a number of old shell stills and auxiliaries will be demolished, several hundred dwellings will be razed, and other auxiliaries such as water supply and power plants will be either enlarged or reconstructed.

From a report on the preliminary operations of this building program it looks as if all the difficulties in the way of proceeding with the plan were removed. It appears, however, that the domestic machine shops which are expected to furnish the major equipment are still far from being able to cope with the task of manufacturing proper equipment and holding to dates of delivery. Glavgormash shops, Podolski Cracking Works and Taganrog, the main sources of supply of oil equipment, are not yet in a position to tackle the problem. Azneftsavodstroi has complained on several occasions that the equipment arriving at Baku from the above sources is of poor quality. Red Boiler Works have shipped to Baku coolers which were manufactured from an inferior grade of scrap iron, already partially corroded. In addition riveting holes were out of measure and bolts did not fit. Most of the coolers had to be used for other purposes or discarded altogether. Baffle plates which go with rectification towers (Taganrog Works) were adjusted to tower walls by force, using heavy hammers, and then set in without accuracy. TECHNIKA states that the domestic manufacturers do not seem to realize that all this sort of equipment has been designed for operation under heavy duty, such as high temperature and pressure, and that artisan handicraft or primitive construction can not be tolerated. The suppliers seem to have overlooked the fact that an infinitesimal fraction of an inch in tower dimensions is reflected in the fractionation of the individual cuts. Podolski Works have shipped to Baku carelessly constructed defective equipment, and tower bodies lack cylindrical form, often having an ellipse of 1/8 in. Baffle plates do not fit to the walls and leak.

Boretz Works of Moscow were late in the delivery of pumps and the Montina Works of Baku were compelled to undertake the manufacture of these pumps. This job has tied up the Montina Works for almost three months and they were unable, therefore, to make scheduled delivery of return bends for cracking.

The paper TECHNIKA further states that projects are incomplete and working drawings are inaccurate. The same mistakes are being made over and over again and no attention is being given to American progress and practice. Lummus economical furnaces are being considered for the new construction, but the Soviet designers, according to TECHNIKA, are not as yet able to comprehend a number of technical details of construction.

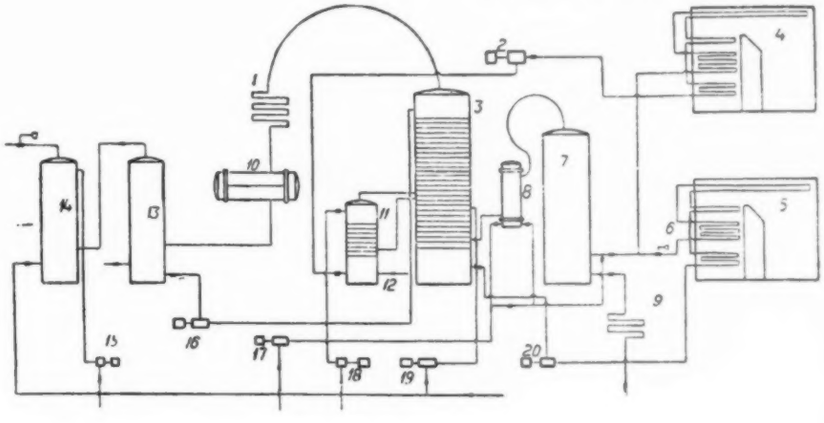
S. ORDZONIKIDZE has emphasized the necessity of improving the quality of tractor kerosene refined in Russia. The inferior grade used by the Soviets vitally affects the working efficiency of tractor motors, 30 h.p. motors driven on Baku kerosene developing only 22 h.p. If standard grades of kerosene were used for all 250,000 Soviet tractors in operation, the total working efficiency would be increased by at least 50 percent.

It would be entirely wrong to assume that Baku crude can not yield kerosene of an octane rating higher than 40–45. Perfected processing would undoubtedly do the trick. There are no inferior grades of crude, but there are inferior methods of refining. In treating crude by fractionation, acidation and neutralization, the separation of hydrocarbons depends mainly upon the boiling point, and not upon chemical grouping. Though the presence of hydrocarbons is desirable in all fuels used in carbureters, they are undesirable in Diesel fuel, illuminating kerosene or gasoline solvents. Methane hydrocarbons are not desirable in fuels for carbureters, but are desirable in Diesel fuel and illuminating kerosene. In other words, where aromatics are desired methane is out of place and therefore crude not only has to be distilled but also decomposed into individual products which vary in chemical properties. All these phases of Soviet oil operations are still in an experimental stage and it will take some time before the laboratory results can be applied in practice.

Ziatim has undertaken interesting tests with Maikop kerosene, which contains about 32 percent aromatic hydrocarbons, but has an octane rating of 22 and a cetene number of 55. Such rating makes the kerosene unsuitable for use in tractors and is also high for illuminating kerosene. Under Ziatim tests, the octane rating was brought up to 50–80. Part of this kerosene was tested for a reduction of aromatics to 10–12 percent and it became suitable for illuminating purposes. Further reductions to 1–2 percent made it a suitable Diesel fuel with a cetene number of 70, which is above the usual rating for

Liquid-vapor phase, Soviet cracking design:

1. is the gasoline cooler, 2. hot oil pump, 3. rectification, 4. and 5. furnaces, 7. evaporator, 8. heat exchanger, 9. and 10. coolers, 11. stripper, 13. gas separator, 14. absorber, 15, 17, 18, 19. and 20. various pumps.

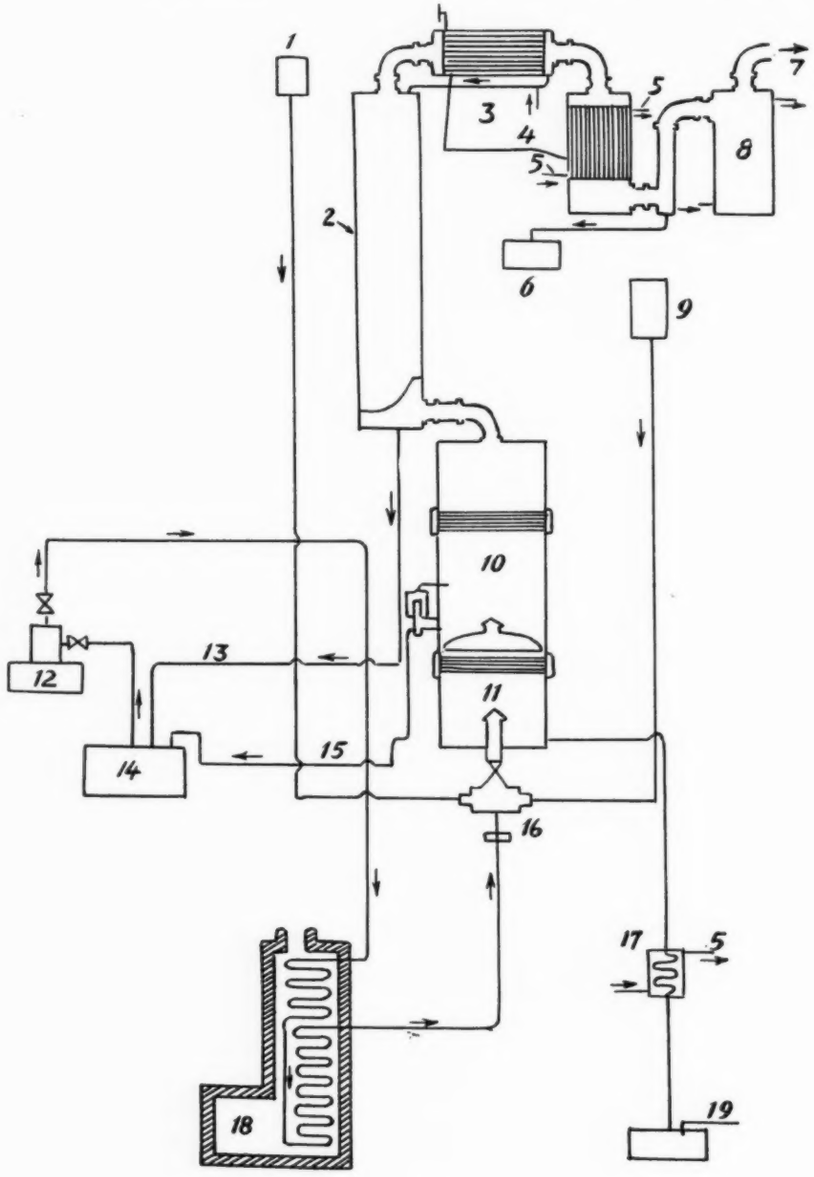


distillates from Pennsylvania crude grades.

Other tests were made with the kerosene—gasoil—solar oil fractions in which the aromatic hydrocarbons were increased to 90 percent and the octane rating was 80. The product was used for blending Baku kerosene of 40–50 octane rating. Aromatics were extracted from these fractions and added to gasoline which then became the finest grade aviation gasoline. Extracted aromatics were also used as a raw material for hydrogenation and the gasoline obtained carried an octane rating of 100.

Shukhoff-Kapelushnikoff cracking system:

1. input, 2. rectification tower, 3. phlegm, 4. condenser, 8. gas scrubber, 10. distillation chamber, 11. evaporator, 12. pump, 13. gas oil, 14. receiver, 16. reduction valve, 17. cooler, 18. furnace, and 19. heavy residue receiver.



Soviet Cracking

THE EARLIEST cracking patents ever issued were granted to two Russian engineers, Shukhoff and Gavriloff, in 1891, some 45 years ago. In 1925–26 Soviet representatives negotiated for the purchase of cracking equipment from M. W. Kellogg in the United States, but placed their first orders with Vickers Ltd. in England. Subsequent orders were placed in Germany and in 1930 they purchased cracking equipment in the United States from Winkler Koch. In 1932 when the Soviets were anxious to curtail the import of oil equipment, the first attempts were made to design and build their own cracking plants.

The question of type of equipment to be built divided Soviet engineering minds into three groups. M. Korobovkin, an engineer of Glavneft advocated the Winkler Koch system with possible modifications. Obriadchikoff, a Soviet petroleum technologist, advocated combined installations similar in form and operation to Dubbs and Cross units. Dubrovaya-Knox strongly advised vapor phase cracking of his own system which was still under test and experiment.

M. Kapelushnikoff, who is known for his turbine drill, designed a vapor phase cracking system in collaboration with Shukhoff and assisted by Prof. Leibenson which the Soviet experts considered an important improvement. Having erected the first installation M. Kapelushnikoff proceeded to convert the system for liquid phase cracking and later for mixed cracking under liquid-vapor phase. Several installations were modified in the form of two furnaces and reducing added.

V. Chochloff, a Soviet petroleum technologist, has described the design, construction and operation of the Soviet cracking installations which are entirely of domestic design and construction, only the pumps and measuring instruments being imported from abroad.

M. Kapelushnikoff was guided by the principle that cracking is regulated by two factors, namely temperature and heating duration. Earlier cracking methods proceeded under the theory of long heating periods at comparatively low temperature. Later experiments, such as made by Cross and Dubbs, were based largely upon heating at much higher temperature. Longer reaction periods were made possible by introduction of reaction chambers. The earliest cracking installations were operated at 5 atm. pressure for capacities of 250 bbl. per day. Dubbs and Cross increased the capacities to 3,500–4,000 bbl. per day, but operated at a pressure of 30–50 atm.

Reaction chambers cause complications in construction as well as in operation and they are costly. These considerations have influenced the Soviet experts to try to avoid reaction chambers by employing more cycles for heating the input; in other words, they introduced recycling, figuring that continuity of operation will be better served when the cracking distillates are multiply subjected to thermal treatment. The distillates may be refinery side streams or cracking distillates under utilization of excess heat from the cracking process. In practice, however, they have found that when cutting 20 percent gasoline under one cycle the excess represented only ⅔ of the required heat.

Petroleum Refineries of the World

Arranged by Countries—Excluding the United States

Company	Head Office	Plant Location	Daily Cap. (BBL.)	Products	Remarks
Argentine					
Cia Ferro-Carrilera de Pet.	Buenos Aires	Comodoro	8,000	Fuel oils only	Topping and Cracking plant
Cia Nacional de Petroleos (Ltda.)	Buenos Aires	Bahia Blanca	2,000	Fuel oils only	Topping and Cracking plant
Cia Nacional de Petroleos (Ltda.)	Buenos Aires	Campana	11,000	Complete line	Topping and Cracking plant
Cia Petrolifera Andina	Buenos Aires	Mendoza	1,200	.....	Topping plant
"Diadema" Argentina, S.A. de Petroleo (Royal Dutch)	Buenos Aires	South Dock, Buenos Aires	10,000	.....	Topping and Cracking plant
"El Condor"	Avellaneda	Avellaneda	450	Fuel oils only	Lube plant
"El Condor"	Avellaneda	Avellaneda (Calla Fraga)	600	Fuel oils only	Topping plant
"El Condor"	Avellaneda	Avellaneda (Rio Cuarto)	1,000	.....	Topping plant
"Itaca" Compania Argentina para la Elaboracion de Productos Petroliferos, S. A.	Buenos Aires	Campana	5,000	.....	Topping plant
Lottero, Bapini y Cia	Buenos Aires	Pineiro	210	.....	Topping plant
Refineria de Petroleo "La Isaura", S. A.	Buenos Aires	Bahia Blanca	1,600	Fuel oils only	Skimming plant equipped with Cracking units
Standard Oil Co. S. A. Argentine	Buenos Aires	Embarcacion	500	Fuel oils only	Topping plant
Standard Oil Co. S. A. Argentine	Buenos Aires	Plaza Huincul	120	.....	Topping plant
Ultramar Sociedad Anonimia Petrolera Argentine	Buenos Aires	Buenos Aires	3,000	Complete line	Cracking units
Yacimientos Petroliferos Fiscales (Argentine Government Oilfields)	Buenos Aires	La Plata	23,000	Complete line	Cracking units
Yacimientos Petroliferos Fiscales (Argentine Government Oilfields)	Buenos Aires	Comodoro Rivadavia	700	.....	Topping plant
Yacimientos Petroliferos Fiscales (Argentine Government Oilfields)	Buenos Aires	Plaza Huincul	400	Fuel oils only	Topping plant
Yacimientos Petroliferos Fiscales (Argentine Government Oilfields)	Buenos Aires	.....	....	.....	Plan small refinery for Mendoza Oilfield. Purchasing office being opened in London
Australia					
Commonwealth Oil Refineries, Ltd.	Melbourne	Kororoit Creek, near Williamstown	2,000	Gasoline, kerosene and fuel oil	Topping plant
Newport Oil Refinery, Ltd.	Newport, Victoria	Newport	60	Lubricating oils	.....
Shell Company of Australia	London	Clyde, near Sydney	2,000	Gasoline, kerosene and fuel oil	Topping and Cracking plant
Austria					
"Austria" Petroleum-Industrie A. G.	Vienna	Vosendorf	1,120	Gasoline, kerosene, gas oil, vulcan oil, road spraying oil, motor oils, car grease, engine grease	Boiler still plant
Creditul Minier Oesterreichisch-Rumanische Petroleum-Vertriebsgesellschaft m. b. H.	Vienna	Drossing	1,000	.....	Shell stills
Creditul Minier Oesterreichisch-Rumanische Petroleum-Vertriebsgesellschaft m. b. H.	Vienna	Korneuburg	2,400	.....	.....
"Okeros" Mineralwachswerk Traub & Co.	Vienna	Stockeran near Vienna	....	.....	.....
Shell-Floridsdorfer Mineralolfabrik, Aktiengesellschaft (Royal Dutch)	Vienna	Floridsdorf	3,800	Complete line	Pipe still
Vacuum Oil Co. A. G.	Vienna	Kagran	1,700	Gasoline, kerosene and lubricating oils	Pipe still
Bahrein Islands					
Bahrein Petroleum Co. (S. O. of Cal.)		Bahrein (Persian Gulf)	....	.....	Concessions call for small refineries at Bahrein and Eastern Saudi Arabia
Belgium					
Belgian Cracking Co., S. A.	Brussels	Langerbrugge-Evergem	450	Gasoline, gas oil and fuel oil	Dubbs Cracking equipment
Belgo Petroleum S. A.	Terdonck	Terdonck	1,250	.....	Cracking units
Compagnie Belge du Gaz Catalytique	Forest	Forest	100	.....	Cracking units
Compagnie Industrielle "Atlas" S. A.	Antwerp	.....	....	.....	Small plant
Raffinerie Belge de Petroles, (R. B. P.)	Antwerp	Antwerp—4th dock	3,800	Gasoline, Gas Diesel fuel, lub. oil and asphalt	Cracking equipment
Raffineries & Distilleries Anversoises, S. A.	Antwerp	Antwerp-Kiel	1,000	Gasoline, kerosene, gas and fuel oil	.....
Redeventa S. A. Belge	Antwerp	Antwerp	2,000	.....	Distillation plant
Societe Chimique de Selzaete	Brussels	Selzaete	200	.....	Not operating at this time

Company	Head Office	Plant Location	Daily Cap. (BBL.)	Products	Remarks
Bolivia					
Standard Oil Company of Bolivia	Buenos Aires, Argentina	Sanadita	200	.....	Skimming plant
Standard Oil Company of Bolivia	Buenos Aires, Argentina	Camira	200	.....	Skimming plant
Canada					
Alberta Hi-Way Refineries, Ltd.	Edmonton	Edmonton	500	.....	Topping plant
Amherst Oil Refineries, Ltd.	Amherstberg, Ont.	Amherstberg	2,500	.....	Skimming plant
Arctic Refineries, Ltd.	Lethbridge	Lethbridge	300	.....	.....
Bell Refining Co., Ltd.	Calgary, Alta.	Calgary	1,000	.....	Skimming plant
British American Oil Co., Ltd.	Toronto	Toronto	5,000	Complete line	Skimming and Cracking plant
British American Oil Co., Ltd.	Toronto	East Montreal	15,000	.....	Skimming and Cracking plant
British American Oil Co., Ltd.	Toronto	Moose Jaw, Sask.	3,000	.....	Skimming plant
British American Oil Co., Ltd.	Toronto	Coutts, Alberta	1,500	.....	Skimming plant with Cracking units
Burlington Refineries, Ltd.	Hamilton	Hamilton	600	.....	Skimming
Canada Southern Oil and Refining Co., Ltd.	Calgary, Alta.	Black Diamond	60	.....	.....
Canadian Oil Companies, Ltd.	Toronto	Petrolia	1,400	Complete line	Skimming and Cracking plant
Comet Oil Refineries, Ltd.	Montreal	Near Montreal	....	.....	Installing a 2,700 bbl. Topping plant and a 2,280 bbl. Cap. Dubbs Cracking unit
Consumers Refineries Cooperative Association	Regina	Regina, Sask.	500	.....	Contract awarded to North West Iron Works, Regina, for construction of Skimming plant
Devenish Petroleum, Ltd.	Calgary	Skiff	....	.....	.....
Direct Oil Refineries, Ltd.	Winnipeg	St. Boniface	200	.....	Skimming
Fraser, J. W., Refining Co.	Wainwright	Wainwright	50	.....	Skimming
Gold. Standard Oils, Ltd.	Wainwright	Wainwright	200	.....	Skimming
Good Rich Refining Co., Ltd.	Toronto	Toronto	250	.....	Skimming
Hi Way Oil Co., Ltd.	New Westminster, B. C.	Surrey, B. C.	200	.....	Skimming plant
Hi Way Refineries, Ltd.	Regina, Sask.	Regina, Sask.	250	.....	Skimming plant
Home Oil Distributors, Ltd.	Vancouver, B. C.	North Vancouver	1,000	Gasoline, kerosene and fuel oil	Topping plant
Home Oil & Refining Co.	Humboldt	Humboldt	300	.....	Topping plant
Imperial Oil, Ltd.	Toronto	Dartmouth, Halifax	17,000	Complete line	Complete with Cracking units
Imperial Oil, Ltd.	Toronto	Montreal	30,000	Complete line	Complete with Cracking units
Imperial Oil, Ltd.	Toronto	Sarnia	22,000	Complete line	Complete with Cracking units
Imperial Oil, Ltd.	Toronto	Regina	7,200	Complete line	Complete with Cracking units
Imperial Oil, Ltd.	Toronto	Calgary	5,000	Gasoline, kerosene and fuel oil	Skimming with Cracking units
Imperial Oil, Ltd.	Toronto	Ioco, Vancouver	16,000	Gasoline, kerosene and fuel oil	Skimming with Cracking units
Karels' Oil Refinery	Regina, Sask.	Regina	250	.....	Topping plant
La Salle Petroleum Refinery, Ltd.	Montreal	East Montreal	2,500	.....	Skimming plant
Lion Refining Co.	Calgary, Alta.	Calgary	250	.....	Skimming plant
Lloyd Refineries, Ltd.	Port Credit	Port Credit	1,500	.....	Skimming and Cracking
Maple Leaf Petroleum, Ltd.	Denver, Colo.	Coutts, Alberta	5,000	Gasoline, kerosene and fuel oils	Skimming plant
McColl-Frontenac Oil Co., Ltd.	Montreal	Montreal	12,500	Gasoline, kerosene and fuel oils	Skimming and Cracking plant
McColl-Frontenac Oil Co., Ltd.	Montreal	Toronto	5,000	Gasoline, kerosene and fuel oils	Skimming and Cracking plant
Moose Jaw Hi-Way Refinery, Ltd.	Moose Jaw	Moose Jaw	200	.....	Skimming plant
New Brunswick Gas & Oilfields, Ltd.	Edinburgh, Scotland	Weldon, B. C.	100	.....	Skimming plant
North Star Oil, Ltd.	Winnipeg	St. Boniface	600	Gasoline, kerosene and fuel oils	Skimming plant
Northwest Co., Ltd.	Toronto	Fort Norman	50	.....	.....
Prince Albert Hi-Way Refinery, Ltd.	Prince Albert	Prince Albert, Sask.	200	.....	.....
Radio Oil Refineries of Canada	Winnipeg	East Kildonan, Man.	1,200	.....	Skimming plant
Regal Petroleum Co., Ltd.	Calgary	Calgary	3,000	Gasoline, kerosene and fuel oil	Skimming plant
Rosetown Hi Way Refineries, Ltd.	Rosetown, Sask.	Rosetown	200	.....	Topping plant
Saskatoon Hi Way Refineries, Ltd.	Saskatoon	Saskatoon	300	.....	Skimming plant
Sava Oil Refineries, Ltd.	Windsor, Ont.	Windsor	1,000	.....	Lube plant
Shell Co. of British Columbia	Vancouver	Burnaby, near Vancouver	3,500	.....	Skimming plant
Shell Oil Co. of Canada, Ltd.	Toronto	East Montreal	3,500	.....	Skimming plant with Cracking units
Standard Oil Co. of British Columbia	San Francisco, Calif.	Near Vancouver	2,500	.....	.....
Swift Current Hi-Way Refinery	Swift Current	Swift Current	200	.....	.....
Vancouver Oil Co., Ltd.	Vancouver	North Vancouver	1,000	.....	Skimming
Weyburn Hi-Way Refinery, Ltd.	Weyburn	Weyburn	300	.....	Skimming
Widney Refineries	Turner Valley	Turner Valley	150	.....	Skimming
Canary Islands					
Compania Espanola de Petroleo S. A. (CEPSA)	Madrid	Santa Cruz de Tenerife	5,000	.....	Topping plant with Cracking units
Chile					
Johannsen, C. H.	Coquimbo	Coquimbo	125	.....	.....
Maritano, Miguel	Talcahuano	Talcahuano	70	.....	.....
Societe de la Fuente, Sampedro, Berrios (Ltda.)	Santiago	Santiago	15	.....	.....
Societe, Establecimientos Fuimicos de Vina del Mar	Vina del Mar	Vina del Mar	174	.....	.....

Company	Head Office	Plant Location	Daily Cap. (BBL.)	Products	Remarks
Colombia					
Tropical Oil Co.	Pittsburgh	Barranca Bermeja	7,000	Gasoline, kerosene, fuel and lub. oils	Skimming plant
Cuba					
Standard Oil Co. of Cuba	Havana	Belot	5,000	Complete line	.....
Czechoslovakia					
"Apollo" Mineraloel-Raffinerie A. G.	Bratislava	Bratislava	800	.....	Will erect Dubbs Cracking plant of 1,000 bbl. daily capacity. Contract placed with Skoda Works
"Apollo" Mineraloel-Raffinerie A. G.	Bratislava	Weikersdorf, near Sumperk	400	.....	.....
Fanto-Werke A. G.	Prague	Pardubice	4,000	Complete line	High vacuum distilling plant, Tube still plant; will build Cracking plant
Fanto-Werke A. G.	Prague	Neu Oderberg	1,100	Gasoline, kerosene, wax and lub. oils	High vacuum distilling plant
Himmelbauer, Karl	Moravska Ostrava	Moravska Ostrava	500	Wax	.....
Kraluper Mineraloel-Raffinerie, Lederer & Co.	Prague	Kralup	600	.....	.....
Petrolea Oel-und Fettwerke A. G.	.....	Uralz, near Prague	....	.....	Plan to build a 1,000 bbl. per day refinery
Privozer Mineraloelwerke	Moravska Ostrava	Moravska Ostrava	1,300	.....	.....
Prva Hornovididiecka Raffineria Petroleja Ehrenberg & Co.	Strazske	Strazske	....	.....	.....
Sudkarpatische Mineraloel-Raffinerie und Handels A. G.	Mukacevo	Mukacevo	120	.....	.....
Vacuum Oil Co. A. S.	Prague	Sendrazice, near Kolin	2,100	Complete line	Atmospheric distillation units
"Vesta" Slowakische Mineraloel-Industrie A. G.	Bratislava	Trstena	200	.....	Boiler still plant
Weinberger and Ortner	Dolne Mihalany	Dolne Mihalany	80	Semi-refined products	.....
Ecuador					
Anglo Ecuadorian Oilfields, Ltd.	London	La Libertad	750	Gasoline, kerosene and fuel oil	.....
Carolina Oil Co.	Guayaquil	Guayaquil	....	.....	.....
Ecuador Oilfields, Ltd.	London	Cuativo	108	Gasoline, kerosene, fuel and lub. oils	.....
Refinery Viggiani Dr. Francisco Illescas B.	Salinas	Carolina	32	.....	.....
Egypt					
Anglo-Egyptian Oilfields, Ltd.	London	Suez	7,000	Complete line	Topping, Cracking and asphalt plant
Government Petroleum Refinery	Cairo	Suez	900	Complete line	Topping plant; will build one unit, F. W. Atmosphere, 1400 bbl. daily
Finland					
Finnish interests at Helsingfors propose to take over and rebuild the Wallenberg shale oil plant at Kohtla, East Estonia, and refine 84,000 bbl. crude oil per annum.					
France					
Brest-Port Petrolier, S. A.	Paris	Bay St. Marc	1,000	.....	.....
Compagnie des Produits Chimiques et Raffineries de Berre	Paris	Berre, near Marseilles	10,000	.....	.....
Compagnie Francaise de Raffinage	Paris	Gonfreville-d'Orcher, near Le Havre	16,800	Complete line	Tube stills and Cracking units
Compagnie Francaise de Raffinage	Paris	Martigues	8,400	Gasoline, kerosene, gas oil, fuel oils and asphalt	Tube still and Cracking plant
Compagnie Francaise de Raffinage	Paris	Near Marseilles on Etang de Berre	8,000	Complete line	Distillation and Cracking plant
Compagnie Industrielle des Petroles	Paris	Frontignan-Cette	3,500	Gasoline and gas oil	Topping plant and Cracking unit
Consommateurs de Petroles	Paris	Donges	.....	.....	.....
Credit Minier Franco-Roumain	.....	.....	.....	.....	Planning to build a refinery in France of 4,000 bbl. daily capacity, or 8,000 bbl. if in conjunction with other companies
Pechelbronn Societe Anonyme d'Exploitations Minieres	Strasbourg	Merkwiller-Pechelbronn	2,500	Complete line	2 Topping plants with Cracking equipment
Pechelbronn-Ouest S. A.	Donges	Donges	....	.....	.....
Raffineries de la Vacuum Oil Co., S. A. F.	Paris	Notre Dame de Gravenchon, S. I.	5,600	Gasoline and lub. oils	Distillation and Cracking; will build Duo-Sol unit
Raffinerie de Petrole du Nord	Paris	Port of Dunkerque	11,500	Complete line	Skimming and Cracking plant
Societe Anonyme des Petrole Jupiter	Paris	Pauillac	8,200	Gasoline, gas oil and fuel oil	Complete plant — S. A. des Petrole Jupiter building Dubbs reforming unit 2,900 bbl. gasoline. Dubbs flashing units,
Societe Anonyme des Petrole Jupiter	Paris	Petit Couronne near Rouen	14,000	Complete line	Complete plant — 4,000 bbl. of topped crude at each refinery

Company	Head Office	Plant Location	Daily Cap. (BBL.)	Products	Remarks
FRANCE—*Continued*					
Societe Lyonnaise des Schistes Bitumineux	Paris	St. Leger du Bois	175	Several products of shale oil	To erect new 315 bbl. per day Bitumen Cracking plant at Les Taloti
Societe Lyonnaise des Schistes Bitumineux	Paris	Auton	450	Several products of shale oil	Under construction; Dubbs full flashing unit. Chantiers de la Loire have erecting contract
Societe de Raffinage des Huiles de Petrole	Paris	Courchelettes	4,000	.....	.....
Societe de Raffinage des Huiles de Petrole	Paris	Martigues-l'Avera	6,800	Gasoline, kerosene, gas oil and fuel oils	Topping plant with Cracking unit
Societe des Raffineries de Petrole de la Gironde	Paris	Bec d'Ambes	6,000	.....	2 Cracking units
Societe Generale des Huiles de Petrole	Paris	Courchelettes	4,000	Complete line	Topping and lubricating oil equipment; Building Cross cracking reforming unit, Alco Fuel Oil Distillation Unit, Edeleanu Solvent Extraction plant
Societe Generale des Huiles de Petrole	Paris	Martigues-l'Avera	6,800	.....	Topping and Cracking plant
Standard Franco-Americaine de Raffinage (S. O. N. J.)	Paris	Port Jerome	20,000	Gasoline, kerosene, gas oil, butane, fuel oil, lub. oil, and asphalt	Skimming and Cracking plant; will build a new propane plant
Belgian-French Interests (name confidential)	.....	.....	....	.....	Planning to build Solvent lube oil plant
Germany					
Berliner Benzin-Werke m. b. H.	Berlin-Lichtenberg	Berlin-Lichtenberg	100	.....	.....
Colner Benzin-Raffinerie G. m. b. H.	Koln-Braunsfeld	Koln-Braunsfeld	....	.....	.....
Danubia A.G. Fur Mineraloel-Industrie	Regensburg	Regensburg	500	.....	.....
Deutsche Gasolin A. G.	Berlin	Emmerich	700	.....	Skimming plant
Deutsche Gasolin A. G.	Berlin	Dollbergen	400	.....	Skimming plant
Deutsche Petroleum A. G.	Berlin	Wilhelmsburg, near Hamburg	1,100	.....	.....
Deutsche Petroleum A. G.	Berlin	Hanover-Linden	300	.....	.....
Deutsche Vacuum Oel A. G. (Socony Vacuum)	Hamburg	Oslebshausen, near Bremen	2,000	Lubricating oils and greases	High vacuum distillation plant; building Duo-Sol unit and acetone-benzole dewaxing plant
Deutsche Vacuum Oel A. G. (Socony Vacuum)	Hamburg	Wedel, Holstein	700	Lubricating oils and greases	High vacuum distillation plant
Ebano Asphalt-Werke A. G.	Hamburg	Harburg-Wilhelmsburg	8,000	Gasoline, kerosene, gas oil and asphalt	Distillation plant
Erdol-Raffinerie Salzbergen G. m. b. H. (Ersag)	Kassel	Salzbergen	700	Gasoline, kerosene, gas and lub. oils, asphalt	Distillation and Cracking plant
Europaische Tanklager-u Transport A. G.	Berlin	Hamburg	10,000	Gasoline, kerosene, gas oil and fuel oil	Distillation and Cracking plant
Gewerkschaft Deutsche Erdol-Raffinerie (Deurag)	Hanover	Misburg, near Hanover	2,100	Complete line	Cracking plant
Kohlenveredlung und Schwelwerke A. G.	Berlin	Golzau, near Cothen	....	.....	.....
Loeb, Max, Benzin-Benzol Mineralolwerke	Koln-Braunsfeld	Koln-Braunsfeld	200	.....	Skimming and Cracking plant
Mexas Kaltasphalt A. G.	Dresden	Neuendorf-Pirna	200	.....	Skimming and Cracking plant
Mineralolraffinerie Rheinau G. m. b. H.	Berlin-Schoneberg	Mannheim-Rheinau	150	.....	.....
Mineralol-Raffinerie vorm. August Korff [Deutsche Amerikanische Pet. Ges., Standard Oil Co. (N. J.)]	Bremen	Bremen	....	Lubricating oils	Lubricating oil refinery
Mineralol-und Asphaltwerke A. G.	Hamburg	Ostermoor	2,300	Asphalt, lub. oil and gas oil	Distillation plant
Mineralolwerke Albrecht & Co.	Hamburg	Hamburg	600	.....	.....
Mineralolwerke Lichtenberg G. m. b. H.	Berlin	Lichtenberg	1,000	Gasoline, kerosene, gas and lub. oils and asphalt	Cracking units
Muhsam, Phillipp, A. G.	Berlin	Berlin-Britz	150	.....	.....
"Nitag"	.....	Petroleumhafen	8,000	.....	Skimming and Cracking unit. Lachman treating system, vapor recovery and stabilisation equipment
Norddeutsche Mineraloel, A.G.	Hanover	Dollbergen	200	.....	Skimming and rerun plant
Raky, Anton, Tufbohrungen A. G.	Bad Salzgitter	Salzbergen	....	.....	.....
Rhenania-Ossag Mineraloelwerke A. G. (Royal Dutch)	Hamburg	Hamburg-Grasbrook	2,000	Lubricants	Lub. plant
Rhenania-Ossag Mineraloelwerke A. G. (Royal Dutch)	Hamburg	Freital, near Dresden	200	Lubricants	Lub. plant
Rhenania-Ossag Mineraloelwerke A. G. (Royal Dutch)	Hamburg	Harburg-Wilhelmsburg	5,000	Asphalt	Asphalt plant

Company	Head Office	Plant Location	Daily Cap. (BBL.)	Products	Remarks
GERMANY—*Continued*					
Rhenania-Ossag Mineraloelwerke A. G. (Royal Dutch)	Hamburg	Regensburg	300	.....	.....
Rhenania-Ossag Mineraloelwerke A. G. (Royal Dutch)	Hamburg	Harburg-Wilhelmsburg	1,200	.....	.....
Rhenania-Ossag Mineraloelwerke A. G. (Royal Dutch)	Hamburg	Monheim	2,000	.....	.....
Rhenania-Ossag Mineraloelwerke A. G. (Royal Dutch)	Hamburg	Reisholz (Duesseldorf)	1,200	.....	.....
Schindler, Julius, Oelwerke G. m. b. H.	Hamburg	Neuhof (Harburg-Wilhelmsburg)	700	Lubricating oils	Distillation and treating equipment
Schindler, Julius, Oelwerke G. m. b. H.	Hamburg	Peine (Hanover)	....	Railroad axle oils	.....
Schliemann's, Ernst, Oelwerke G. m. b. H.	Hamburg	Hamburg-Grasbrook	....	Lubricating oils	Refinery and lub. plant
Schliemann's, Ernst, Oelwerke G. m. b. H.	Hamburg	Harburg-Wilhelmsburg	....	Lubricating oils	Lub. plant
Westfalische Mineraloel-und Asphalt-Werke W. H. Schmitz Komm-Gesellschaft	Dortmund	Dortmund-Sud	150	.....	.....
Zeller & Gmelin	Eislingen	Eislingen	....	Lub. oils and gasoline for industrial use	Lub. and Redistill gasoline plant
(Name of Company Confidential)		Hanover	....	.....	To install a Solvent plant
Hungary					
"Fanto" Vereinigte Ungarische Mineraloelfabriken A. G.	Budapest	Budapest	1,100	Gasoline, white spirit, kerosene, gas oil, lub. oils, asphalt and greases	High vacuum boiler still plant
"Fanto" Vereinigte Ungarische Mineraloel fabriken A. G.	Budapest	Satoralja Ujhely	280	.....	Boiler still plant
Hazai Koolajipar R. T.	Budapest	Budapest	1,170	Gasoline, kerosene, gas and lub. oils and asphalt	Skimming and Topping plant
Nyirbogdanyer Petroleum Fabrik A. G.	Budapest	Nyirbogdany	280	.....	.....
Shell Mineraloel A. G.	Budapest	Budapest-Csepel Harbor	2,300	Gasoline, kerosene, gas and lub. oils	Vacuum distillation plant
Ungarische Petroleum Industrie Aktien Gesellschaft (Magyar Petroleum Ipar R. T.)	Budapest	Budapest	2,000	Complete line	.....
Vacuum Oil Co., R. T.	Budapest	Almas Fuzito	2,100	Gasoline, kerosene, gas and lub. oils	High pressure distillation plant
India					
Assam Oil Co., Ltd.	London	Digboi	7,000	Complete line	Reconstructing Dubbs units and enlarging capacity
Attock Oil Co., Ltd.	London	Rawalpindi	2,000	Gasoline, kerosene, lub. and fuel oils	Boiler stills with fractionating towers
British Burmah Petroleum Co., Ltd., The	London	Thilawa, on Rangoon River	2,500	Gasoline, kerosene, wax and fuel oil	Still and Cracking equipment
Burmah Oil Co., Ltd.	Glasgow	Syriam, on Peju River	27,500	Complete line	Cracking equipment
Indo-Burma Petroleum Co., Ltd.	Rangoon	Seikgyi, on Rangoon River	3,500	Complete line	Skimming and Cracking plant
Indo-Burma Petroleum Co., Ltd.	Rangoon	Kindat, on Chindwin River	300	Gasoline, kerosene and fuel oil	Skimming plant
Nathaingh Oil Co., Ltd.	Yenangyaung	Yenangyaung	200	Gasoline, kerosene and lub. oil	.....
Sarawak Oilfields, Ltd.	Miri	Lutong, Miri	....	.....	.....
Iran					
Anglo-Iranian Oil Co., Ltd.	London	Abadan	160,000	.....	Complete plant; Constructing new units and modernisation, increasing capacity by 65,000 bbl. per day. Further units proposed for next year
Anglo-Iranian Oil Co., Ltd.	London	Masjid-i-Sulaiman	....	.....	Topping plant
Anglo-Iranian Oil Co., Ltd.	London	Kermanshah	....	.....	Building new refinery
Anglo-Iranian Oil Co., Ltd.	London	Iran	....	.....	Considering a 10,000 bbl. per day lube oil plant
Iraq					
Iraq Petroleum Co., Ltd.	London	Baba Gurgur, near Kirkuk	150	Gasoline, kerosene and fuel oil	Topping plant; A new refinery to be built. Contract placed with Foster-Wheeler, Ltd. for stabilization units
Khanaquin Oil Co., Ltd.	London	Alwand	2,500	Gasoline, kerosene and fuel oil	Skimming plant
Ireland					
Cork Harbour Oil Wharves, Ltd.	London	Haulbowline, Cobh.	600	Gasoline, kerosene, gas oil and fuel oil	Distillation plant
Italy					
Aquila (Redeventza)		Trieste	....	.....	Plan to build Foster-Wheeler-Borsig refinery, capacity 7,000 bbl. a day

Company	Head Office	Plant Location	Daily Cap. (BBL.)	Products	Remarks
ITALY—*Continued*					
Azienda Commerciale Italiana Olii Minerali, S. A.	.....	Genoa	....	.....	Plan to build complete refinery at Tripoli, Syria. 1,100 bbl. per day capacity; later to be increased to 3,500 bbl. per day
Cispadana	Milan	Foggia	....	.....	Plan to build refinery near Foggia to handle Albanian crude
Distillazione Italiana Combustibili S. A. (Dicsa)	Venice	Marghera (Venice)	5,000	Gasoline	Skimming and Cracking plant; Rebuilding Cracking plant
Nafta (R. D. S.)	.....	Spezia	....	.....	To rebuild cracking plant to complete refinery. Also probably build a new refinery elsewhere in Italy
Petroli D'Italia S. A.	Milan	Fiorenzuola d'Arda	200	.....	.....
Raffineria de Olii Minerali Societa Anonima (ROMSA)	Fiume	Fiume	2,000	Complete line	Skimming and Cracking plant; rebuilding Cracking plant. Italian Gov't also building new refineries at Leghorn and Bari
Raffineria Triestina di Olii Minerali	Trieste	Trieste	1,000	.....	.....
Raffineries de la Vacuum Co. S. A. F. (Socony-Vacuum)	Naples	Naples	1,400	.....	Skimming and Cracking plant; may rebuild Benit's Cracking plant to complete refinery, including Duo-Sol and acetone-benzole dewaxing units
Societa per La Industria Italiana del Petrolio	Spezia	Spezia	1,400	Gasoline, kerosene, Diesel oil and coke	Two Cracking units
Societa Petrolifera Italiana	Fornovo Taro (Parma)	Fornovo Taro (Parma)	1,000	Gasoline, refined oil, Diesel oil, fuel oil	Topping plant
Japan					
Asahi Oil Refinery Co.	Tokyo	Tokyo	250	.....	.....
Asahi Oil Refinery Co.	Tokyo	Hikoshima, Yamaguchi	250	.....	.....
Manchurian Railways	.....	Fushun (Manchuria)	....	.....	Building 700 bbl. per day Dubbs plant to handle shale Oil
Maruzen Machine Oil Co.	Osaka	Osaka	680	.....	.....
Maruzen Machine Oil Co.	Osaka	Niitsu, Niigata	....	.....	.....
Mitsubishi Oil Co., Ltd.	Tokyo	Ogimachi, Kawasaki City	5,000	.....	Skimming and cracking plant
Nippon Oil Co., Ltd.	Tokyo	Kudamatsu	3,500	.....	Skimming and cracking plant
Nippon Oil Co., Ltd.	Tokyo	Kashiwazaki	2,800	.....	Skimming and cracking plant
Nippon Oil Co., Ltd.	Tokyo	Niigata	2,800	.....	Skimming and cracking plant
Nippon Oil Co., Ltd.	Tokyo	Akita	3,000	.....	Skimming and cracking plant
Nippon Oil Co., Ltd.	Tokyo	Tsurumi	3,500	.....	Skimming and cracking plant
Nippon Oil Co., Ltd.	Tokyo	Karukawa, Hokkaido	300	.....	Cracking units
Nippon Oil Co., Ltd.	Tokyo	Byoritsu	200	.....	Cracking units
Ogura Oil Co., Ltd.	Tokyo	Tokyo	3,500	.....	Skimming and cracking plant
Ogura Oil Co.	Tokyo	Ysurumi, Kanagawa	1,500	.....	.....
Toyo Petroleum K. K.	Osaka	Osaka	340	.....	.....
Korean Petroleum Co.	.....	.....	....	.....	Formed by Japanese interests with capital of $3,000,000 to build oil refinery in Korea
Latvia					
Oehlrich, A., & Co.	Riga	Muehlgraben	150	.....	Skimming plant
Mexico					
Cia Mexicana de Petroleo "El Aguila" S. A. (Mexican Eagle Oil Co., Ltd.)	Mexico City	Minatitlan	30,000	.....	Complete plant
Cia Mexicana de Petroleo "El Aguila" S. A. (Mexican Eagle Oil Co., Ltd.)	Mexico City	Tampico	40,000	.....	Complete plant including large asphalt plant
Cia Mexicana de Petroleo "El Aguila" S. A. (Mexican Eagle Oil Co., Ltd.)	Mexico City	Atzcapotzalco (near Mexico City)	7,500	.....	Complete plant with special coking system
Huasteca Petroleum Co.	Mexico City	Tampico	20,000	.....	Complete plant equipped with cracking units
Petroleos de Mexico, S. A.	Mexico City	Tampico	1,500	.....	Topping
Pierce Oil Co., S. A.	New York	Tampico	10,000	.....	Skimming and lube plant
Netherlands					
De Bataafsche Petroleum Mij. N. V.	The Hague	Rotterdam	5,700	.....	Addition of 7,000 bbl. Dubbs unit
Netherland India					
Algemeene Petroleum Cia.	Amsterdam	Klantoeng	100	.....	.....
De Bataafsche Petroleum Mij. N. V.	The Hague	Balikpanan	35,000	.....	Complete plant with cracking equipment

Company	Head Office	Plant Location	Daily Cap. (BBL.)	Products	Remarks
NETHERLAND INDIA—*Continued*					
De Bataafsche Petroleum Mij. N. V.	The Hague	Pangkalan Brandan	12,000	.....	Complete plant; additional units being installed
De Bataafsche Petroleum Mij. N. V.	The Hague	Pladjoe	18,000	.....	Complete plant
Nederlandsche Koloniale Petroleum Mij.	The Hague	Kapocan, Java	5,000	.....	.....
Nederlandsche Koloniale Petroleum Mij.	The Hague	Soengei Gerong, Sumatra (Palembang Ref.)	25,000	.....	Cracking units
Netherlands West Indies					
Arends Petroleum Co.	The Hague	Druif, Island of Aruba	22,000	.....	Complete new plant; building additional cracking units
Curacaosche Petroleum Ind. Mij.	The Hague	Willemstad, Curacao	165,000	.....	Complete plant; constructing reforming units and various improvements
Lago Oil & Transport Co., Ltd. (Of Canada)	New York	St. Nicholas, Island of Aruba	115,000	.....	Complete plant
Norway					
Vallo Oljeraffineri A/S	Oslo	Vallo, near Tonsberg	1,000	.....	Skimming plant
Peru					
Establecimiento Industrial de Petroleo De Zorritos	Callao	Zorritos	1,000	.....	Skimming plant
International Petroleum Co.	Toronto	Talara	16,000	.....	Skimming and cracking plant
Poland					
Dr. Bacher I Spolka, Rafinerja Olejow Mineralnych	Derezyce	Derezyce	100	.....	Topping plant
"Bolechow" Zwiazkowa Rafinerja Nafty I Zaklady Przemyslowe, Spolka Z. O. O.	Dolzka	Dolzka	100	.....	Topping plant
Boryslawska S. A. Przetworow Oleju Skalnego	Boryslaw	Boyrslaw	50	.....	Topping plant
Chaskiel Gleicher I Syn	Ropica Polska	Ropica Polska	100	Complete line	Complete plant
Derezycka Rafinerja Olejow Mineralynch I Fabryka Produktow Chemicznych Spolka Z. O. O.	Derezyce	Derezyce	125	Complete line	Complete plant
Ehrenberg, Samuel, & Hollender	Gorlice	Gorlice	100	.....	Topping plant
"Eka" Rafinerja Olejow Mineralnych Spolka Z. O. O.	Grabowiec	Grabowiec	200	Complete line	Complete plant
"Fanto" (Spolka Akcyjna "Fanto")	Lwow	Ustrzyki Dolne	1,000	.....	.....
Friedman, J. S	Kolomyja	Kolomyja	100	.....	Topping plant
"Frymeta" Krajowa Rafinerja Nafty I Fabryka Wytworrow Chemicznych Spolka Z. O. O.	Drohobycz	Drohobycz	100	.....	Complete plant
Galicyjskie Towarzystwo Naftowe "Galicja" Spolka Akcyjna	Lwow	Drohobycz	3,000	.....	Complete with cracking equipment; has ordered a Foster Wheeler pipe still unit for atmospheric and vacuum distillation
"Gazolina" S. A.	Lwow	Hubicze	60	.....	.....
"Gazy Ziemne" Spolka Akcyjna Dla Przemyslu Naftowego I Gazow Zem	Lwow	Zniesienie, near Lwow	500	.....	Skimming plant
Haber Freres, G. n. b. H.	Stanislawow	Stanislawow	150	.....	.....
Hubicka Rafinerja Olejow Mineralnych Sp. Z. O. O.	Drohobycz	Hubicze	100	.....	Topping plant
Jaslow, Industrial Oil Works, "Gartenberg And Schreier" In Jaslo	Jaslo	Nieglowice, near Jaslo	1,100	.....	.....
"Limanowa" (Towarzystwo Naftowe "Limanowa" Spolka Z. O. O.)	Boryslaw	Limanowa	2,000	.....	.....
Malopolski Przmemyal Olejow Mineralnych Spolka Z. O. O.	Lwow	Lesko, near Sanok	100	.....	Topping plant
Malopolskie Towarzystwo Dla Przemyslu Naftowego "Kleczany" Spolka Z. O. O.	Kleczany	Kleczany	100	.....	Topping plant
"Nafta" Spolka Akcyjna	Lwow	Drohobycz	100	.....	Skimming and cracking plant
"Naftamin" Spolka Akcyjna, Dla Przemyslu Naftowego	Ligota Pszczynska	Ligota Pszczynska	300	.....	Complete plant
Pierwsza Stanislawowska Fabryka Nafty Oleju Maszynowego I Benzyny Eisiga Chaim Griffla	Mykietynce	Mykietynce	175	.....	Topping plant
"Polmin" State Oil Works In Drohobycz ("Polmin" Panstwowa Fabryka Olejow Mineralnych	Lwow	Drohobycz	3,500	.....	.....
"Polska Nafta" S. A.	Kolomyja	Kolomyja	100	.....	Topping plant
"Polskie Zwiazkowe Refinerje Olejow Skalnych S. A. (Polish United Oil Refineries)	Lwow	Rychcice, near Drohobycz	700	.....	.....
Polskie Zwiazkowe Refinerje Olejow Skalnych S. A. (Polish United Oil Refineries)	Lwow	Trzebionka	1,400	.....	.....

Company	Head Office	Plant Location	Daily Cap. (BBL.)	Products	Remarks
POLAND—*Continued*					
Rafinerja Nafty "Gleboka" Spolka Z. O. O.	Gleboka, near Sambor	Gleboka, near Sambor	100	.....	Topping plant
Rafinerja Nafty I Fabryka Olejow Massynowych M. H. Reich I Ska	Stryj	Stryj	250	.....	Topping plant
Rafinerja Nafty I Olejow Mineralnych Adolf Krau	Krechowicach	Krechowicach	100	.....	Topping plant
Rafinerja Nafty "Iwonica" Spolka Z. O. O.	Targowiska	Targowiska	100	.....	Topping plant
Rafinerja Olejow Mineralnych Inz. Dr. Baltuch, Lieberman I Marmelstein	Boryslaw	Boryslaw	100	.....	Topping plant
Rafinerja Olejow Mineralnych "Segli" Spolka Z. O. O.	Nadworna	Nadworna	200	.....	.....
Rafinerja Skawinska Zaklady Dla Przemyslu Oleju Skalnego, Griffel I Ska	Skawina	Skawina	300	.....	Topping plant
Rafinerja "Wierbiarz" At Kolomyja, Fabryka Przetworow Olejow Skalnych	Wierbiarz	Wierbiarz	100	.....	Complete plant
Standard Nobel Co. In Poland Ltd. (Standard-Nobel W Polsce Spolka Akcyjna)	Warsaw	Libusza, near Gorlice	1,100	.....	Modern plant
Stawiarski & Co., R. W. (Fabryka Nafty "Walerjan Stawiarski I Ska" Sp. Z. O. O.)	Krosno	Krosno	600	.....	.....
Vacuum Oil Co., S. A.	Czechowice	Czechowice	2,500	.....	Modern cracking equipment
Zachariasz Handel	Drohobycz	Drohobycz	100	.....	Skimming plant
Zielenievski & Fitzner Gamper	Krakow	Krakow	....	.....	Refinery under construction by Foster Wheeler
Roumania					
Astra Romana	Bucarest	Ploesti-Sud	40,000	Complete line	Distillation, high vacuum and cracking plant
Astra Romana-Xenia	.....	Ploesti-Nord	6,000	Gasoline, kerosene, gas and fuel oil	
Berman, J.	.....	Bucovat-Chisinau	180	Gasoline, kerosene, gas and fuel oil	
Bernstein, H. S.	.....	Lucacesti-Bacau	55	Gasoline, kerosene, gas and fuel oil	
Bitum Matita	.....	Matita-Prahova	22	Gasoline, kerosene, gas and fuel oil	
Blum, B. & Z. Fainaru	.....	Margineni-Bacau	220	Gasoline, kerosene, gas and fuel oil	
Carmen Petrol	Bucarest	Ulmi-Targoviste	2,250	Gasoline, kerosene, gas and fuel oil	Skimming plant
Ciocardel, N. V.	.....	Matita-Prahova	44	Gasoline, kerosene, gas and fuel oil	
Colombia	Bucarest	Ploesti-Sud	6,000	Gasoline, kerosene, gas and fuel oil	Skimming and Cracking plant
Cometa	Bucarest	Ploesti-Nord	3,000	Gasoline, kerosene, gas and fuel oil	Skimming plant
Concordia-Vega	Bucarest	Ploesti-Nord	31,000	Complete line	Vacuum distillation plant
Creditul Minier	Bucarest	Brazi-Prahova	8,400	Complete line	Pipe still and cracking units; Will probably build a Solvent lubricating plant
Creditul Minier	Bucarest	Aurora-Balcoi	6,600	Gasoline, kerosene, gas and fuel oil	Skimming plant
Dacio Romano Pet. Synd.	London	Ploesti-Nord	7,300	Gasoline, kerosene, gas and fuel oil	Skimming plant
Dumbrava	.....	Targoviste	330	Gasoline, kerosene, gas and fuel oil	.....
Fazla	.....	Adjud	33	Gasoline, kerosene, gas and fuel oil	.....
Fratia	.....	Ploesti-Sud	3,200	Gasoline, kerosene, gas and fuel oil	.....
Freund Fratii	.....	Satu Mare	133	Gasoline, kerosene, gas and fuel oil	.....
Friedmann, J.	.....	Dej	800	Gasoline, kerosene, gas and fuel oil	.....
Grigorescu, J.	.....	Priseaca-Targoviste	1,600	Gasoline, kerosene, gas and fuel oil	.....
Grunberg, A. D.	.....	Lucacesti-Bacau	30	Gasoline, kerosene, gas and fuel oil	.....
Haimsohn, C.	.....	Buhusi	55	Gasoline, kerosene, gas and fuel oil	.....
Haimsohn, M.	.....	Lucacesti-Bacau	66	Gasoline, kerosene, gas and fuel oil	.....
Industriile de Petrol Orsova-Tileagd Societate Anonima	Orsova	Orsova	1,000	Gasoline, white spirit, kerosene, gas oil, lub. oils, wax and asphalt	Boiler still plant
Industriile de Petrol Orsova—Tileagd Societate Anonima	Orsova	Tileagd	1,100	.....	Boiler still plant
Leibu, Alik	.....	Lucacesti-Bacau	66	Gasoline, kerosene, gas and fuel oil	.....
Niculescu, Ciufu J.	.....	Ulmi-Targoviste	650	Gasoline, kerosene, gas and fuel oil	.....
Noris	.....	Ploesti-Sud	1,350	Gasoline, kerosene, gas and fuel oil	.....

Company	Head Office	Plant Location	Daily Cap. (BBL.)	Products	Remarks
ROUMANIA—*Continued*					
Peckerman, J.	.....	Luncani-Bacau	11	Gasoline, kerosene, gas and fuel oil	.....
Petrol Block Standard	Bucarest	Ploesti-Sud	15,000	Complete line	Skimming plant
Petrol Block Baneasa	Bucarest	Bucarest-Baneasa	2,000	Complete line	Vacuum distillation
Petrolul Bucuresti	.....	Bucarest-Grivita	4,650	Gasoline, kerosene, gas and fuel oil	.....
Petrolul Bucovinean	.....	Rohozna-Cernauti	450	Gasoline, kerosene, gas and fuel oil	.....
Petrol Latina	Bucarest	Plopeni-Prahova	1,200	Gasoline, kerosene, gas and fuel oil	Skimming plant
Petrolmina	Bucarest	Ploesti-Sud	3,300	Gasoline, kerosene, gas and fuel oil	Skimming plant
Photogen	Brasov	Brasov	1,350	Gasoline, kerosene, gas and fuel oil	Vacuum distillation plant
Progresul	Bucarest	Tatarani-Prahova	330	Gasoline, kerosene, gas and fuel oil	.....
Rafinaria de Petrol	.....	Tg.-Mures	400	Gasoline, kerosene, gas and fuel oil	.....
Redeventa	Bucarest	Ploesti-Nord	4,650	Gasoline, kerosene, gas and fuel oil	Skimming plant
Revoil	.....	Baicoi-Prahova	160	Gasoline, kerosene, gas and fuel oil	.....
Romano-Americana (S. O., N. J.)	Bucarest	Ploesti-Teleajen	30,000	Complete line	Cracking plant; to build a new pipe still and stabiliser unit and perhaps Phenol solvent unit
Scheffler, B. S.	.....	Lucacesti-Bacau	45	Gasoline, kerosene, gas and fuel oil	.....
Schwartz, A.	.....	Onesti-Bacau	180	Gasoline, kerosene, gas and fuel oil	.....
Schwartz, A.	.....	Lucacesti-Bacau	33	Gasoline, kerosene, gas and fuel oil	.....
Smarack, Dr. D.	.....	Rozmov-Neamt	330	Gasoline, kerosene, gas and fuel oil	.....
Soc. Generala Mine & Petrol	.....	Doicesti-Dambovita	2,700	Gasoline, kerosene, gas and fuel oil	.....
Steinberg, H. I.	.....	Brasov	400	Gasoline, kerosene, gas and fuel oil	.....
Steaua Romana	Bucarest	Campina	31,000	Complete line	Cracking plant; to construct a McKee pipe still for lube oil, a reforming and distillation unit, and two Braun stabilization units
Steaua Romana	Bucarest	Moinesti	1,780	Gasoline, kerosene, gas and fuel oil	.....
Titan	.....	Bucarest-Cioplea	1,070	Gasoline, kerosene, gas and fuel oil	.....
Unirea Orion	Bucarest	Ploesti-Sud	14,400	Complete line	Topping and Cracking plant
Unirea Speranta	Bucarest	Ploesti-Sud	9,800	Complete line	Topping and Cracking plant
Venus	.....	R. Sarat	1,460	Gasoline, kerosene, gas and fuel oil	.....
Victoria	.....	Colanu-Dambovita	80	Gasoline, kerosene, gas and fuel oil	.....
Zilberman, N.	.....	Lucacesti-Bacau	33	Gasoline, kerosene, gas and fuel oil	.....
U. S. S. R. (Soviet Russia)					
Glavneft	Baku	Baku	330,000	.....	16 Shell stills, 12 Pipe stills, 16 Lubeoil units and 4 Cracking units
Glavneft	Batum	Batum	96,000	.....	One Shell still, 4 Pipe stills, one Lubeoil unit and 6 Cracking units
Glavneft	Grozni	Grozni	300,000	.....	7 Shell stills, 9 Pipe stills, 3 Lubeoil units and 14 Cracking units
Glavneft	Tuapse	Tuapse	52,500	.....	One Shell still, 2 Pipe stills and 2 Cracking units
Glavneft	Krasnodar	Krasnodar	22,000	.....	2 Shell stills and one Pipe still
Glavneft	Gorki-Konstantinovka	Gorki-Konstantinovka	12,500	.....	4 Shell stills, one Pipe still, one Lubeoil unit and one Cracking unit
Glavneft	Yaroslavl	Yaroslavl	5,000	.....	One Lubeoil unit
Glavneft	Santo Chimion	Santo Chimion	3,500	.....	2 Shell stills
Glavneft	Khabarovsk	Khabarovsk	4,000	.....	One Cracking unit
Glavneft	Saratoff	Saratoff	21,000	.....	6 Cracking units
Glavneft	Moscow	Moscow	....	.....	One Shell still
Glavneft	Odessa	Odessa	....	.....	One Shell still
Glavneft	Leningrad	Leningrad	....	.....	One Pipe still
Glavneft	Varinsk	Varinsk	....	.....	One Shell still

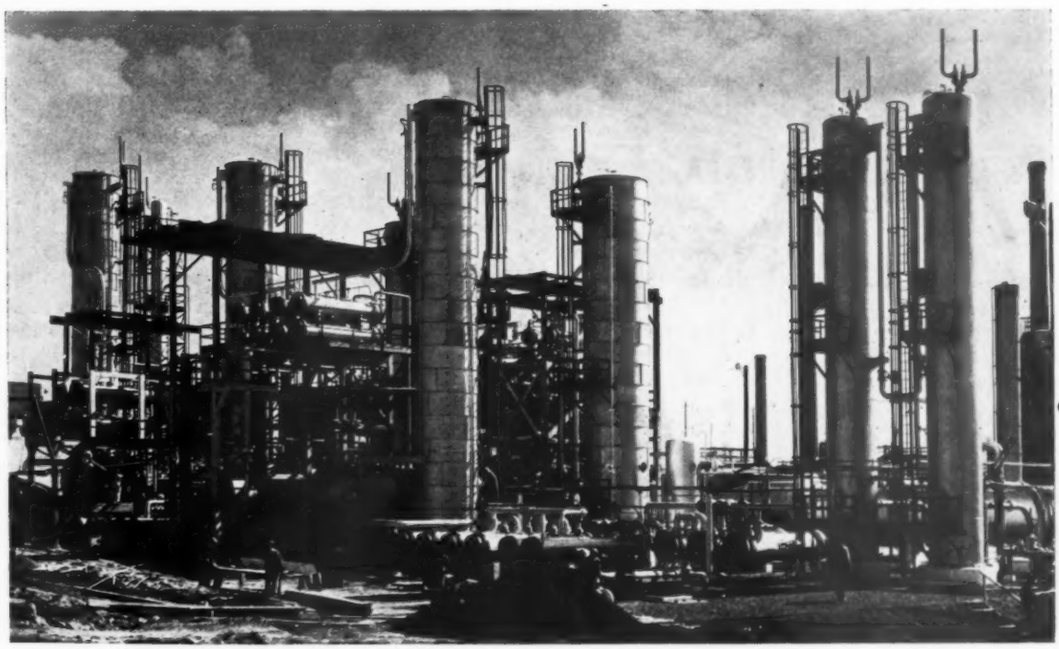
The following refining facilities are scheduled to be in operation by December 31, 1935: 2 Cracking units at Saratoff of 7,000 bbl. daily cap.; 4 Cracking units at Grozni of 14,000 bbl. daily cap.; 4 Cracking units at Baku of 11,200 bbl. daily cap.; 4 Pipe stills at Baku of 117,000 bbl. daily cap.; one Pipe still at Ufa of 12,000 bbl. daily cap.; one Lubeoil unit at Yaroslavl of 2,800 bbl. daily cap.; one Pipe still at Orsk of 12,000 bbl. daily capacity. Glavneft has given contract to Alco International for distillation units to be constructed at Ufa, cost £250,000.

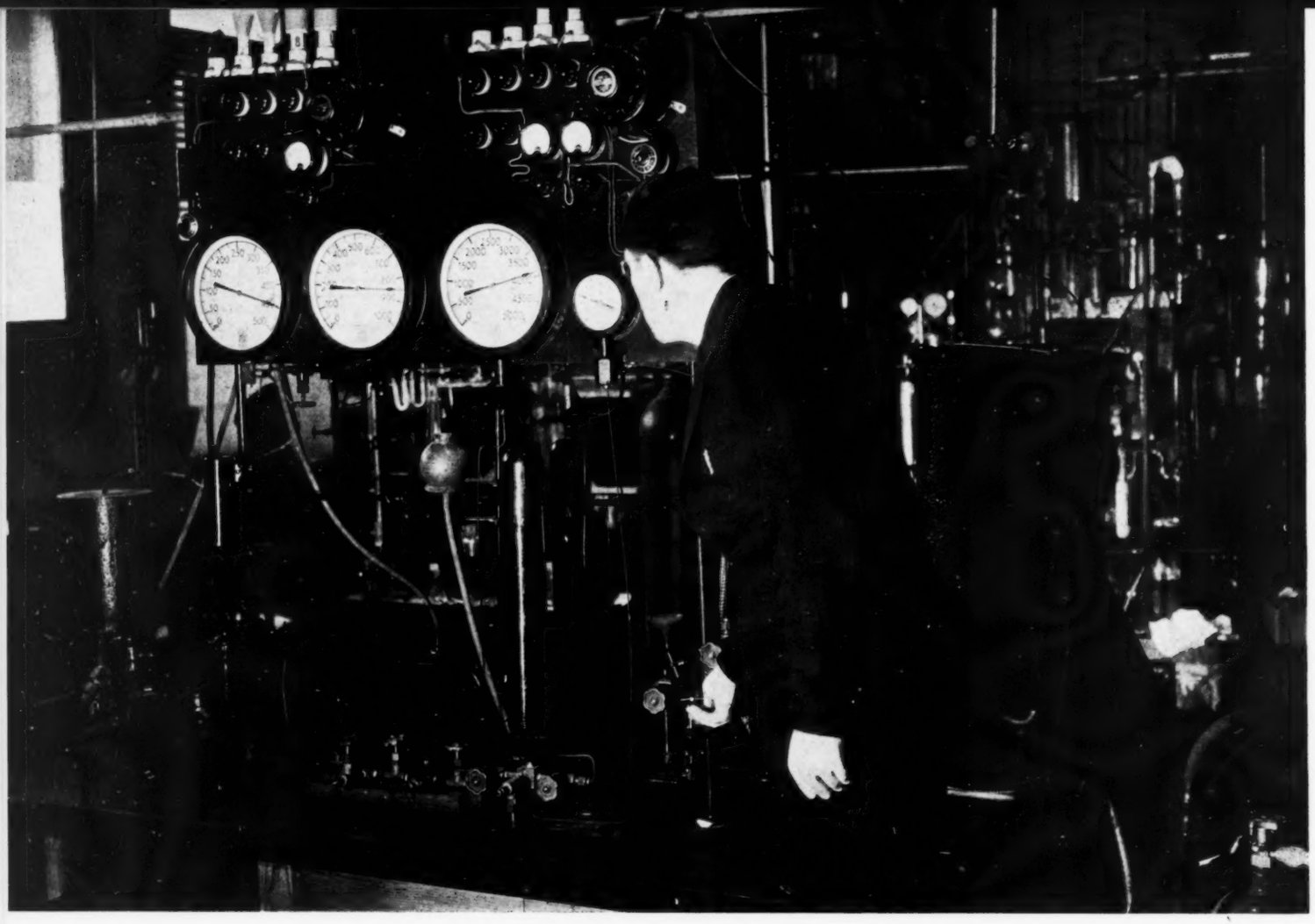
Spain

Compania Arrendataria del Monopolio de Petroles S. A. (Campsa)	Madrid	Barcelona	700	Gas oil and lubricants	Skimming plant

Company	Head Office	Plant Location	Daily Cap. (BBL.)	Products	Remarks
SPAIN—*Continued*					
Campsa (Spanish Petroleum Monopoly)	.....	Santander	....	.....	Will construct new refinery including distillation unit at Santander
Sweden					
Johnson, A., & Co	Stockholm	Nynashamn	1,200	Gasoline, kerosene, fuel oil and asphalt	Cracking equipment
Trinidad					
Kern Trinidad Oilfields, Ltd.	London	Trinidad	1,000	.....	Topping plant
Silvaray Refinery	Trinidad	San Francique	25	.....	Topping plant
Trinidad Central Oilfields, Ltd.	London	Tabaquite	350	.....	Skimming plant
Trinidad Lake Asphalt Co., Ltd.	Philadelphia	Brighton	1,000	.....	Topping plant
Trinidad Leaseholds, Ltd.	London	Point-a-Pierre	20,000	.....	Complete, with Cracking equipment; considering solvent process installation for production of Diesel oil, and completing 10,000 bbl. topping plant
United British Oilfields of Trinidad, Ltd.	London	Point Fortin	5,000	.....	Topping plant
West India Oil Co.	New York	Point d'Or	1,000	.....	Skimming plant
Union of South Africa					
South African Torbanite Mining & Refining Co.	.....	Ermelo, Transvaal	....	.....	Building 1,000 bbl. per day distillation unit for handling shale oil
United Kingdom					
Agwi Petroleum Corp., Ltd.	London	Fawley	13,000	Complete line	Topping plant and Cracking units; will add stabilizer and SO_2 plant. Value £50,000
Anglo-American Oil Co., Ltd.	.....	Port Ellesmere	....	.....	To install some new units, including Alco specialty plant
Berry, Wiggins & Co., Ltd.	London	Kingsnorth-on-the-Medway, near Rochester, Kent	2,300	Complete line	Distillation plant
Berry, Wiggins & Co., Ltd.	London	Weaste, near Manchester	1,500	Complete line	Distillation plant; will add Spirit Flash Unit
Cory Brothers & Co., Ltd.	Cardiff, Wales	Coryton	6,000	Gasoline, kerosene, gas oil, fuel oil and coke	Distillation and Cracking plant; extensions from time to time proposed to meet needs of business
Doncaster Coalite, Ltd.	London	Askem, near Doncaster, Yorks	3,500	Coal-oil, fuel oil, coal petrol	Coalite process
Green, Herbert, & Co., Ltd.	London	East Halton, Lincolnshire	1,500	Lubricating oils	Solvent refining plant
I. C. I. (Fertilizer & Synthetic Products) Ltd.	Billingham, Stockton-on-Tees	Billingham-on-Tees	2,800	Gasoline	Hydrogenation plant
Joy, Edward & Sons, Ltd.	Hunslet, Leeds	Hunslet, Leeds	....	.....	.....
Lobitos Oilfields, Ltd.	London	Ellesmere Port	2,000	Complete line	Cracking unit
London and Thames Haven Oil Wharves, Ltd.	London	Thames Haven, Essex	20,000	Gasoline, kerosene, gas oil and fuel oil	Topping plant; will build extension to existing refinery. Contract with Foster-Wheeler. Just completed Bitumen plant
Low Temperature Carbonisation, Ltd.	London	Barugh, near Barnsley, Yorks	1,750	Coal-oil, fuel oil, coal petrol	Coalite process
Major & Co., Ltd.	London	Hull	1,100	Gasoline, kerosene, and gas oil	Distillation plant
Medway Oil & Storage Co., Ltd.	Grain Halt, Isle of Grain, near Rochester, Kent	Isle of Grain	....	Gasoline, kerosene, and special products	.....
National Oil Refineries, Ltd.	London	Llandarcy, Wales	20,000	.....	Cracking units
Pumpherston Oil Co., Ltd.	Glasgow	Pumpherston	....	Shale oil	.....
Redline-Glico, Ltd.	London	West Ham, London	....	Gasoline, fuel oil, lub. oil, turpentine	Distillation and Cracking equipment
Scottish Oils, Ltd.	Glasgow	Grangemouth, Scotland	14,000	.....	Cracking units
Scottish Oils, Ltd.	Glasgow	Uphall, Scotland	3,000	.....	Cracking units
Scottish Oils, Ltd.	Glasgow	Oakbank, Scotland	....	Shale oil	.....
Shell Refineries, Ltd.	London	Shell Haven	7,000	Complete line	Distillation plant
Shell Refineries, Ltd.	London	Stanlow, Ellesmere Port	4,700	Complete line	Distillation plant
Shell Refineries, Ltd.	London	Ardrossan, Scotland	4,000	Industrial and road asphalts	Distillation plant
Worringham, Edward & Co., Ltd.	.....	Deptford, S. E. 8	....	.....	To completely rebuild existing lube oil refinery
Uruguay					
Ancap (Uruguayan Petroleum Monopoly)	.....	Montevideo	3,800	.....	Contract placed with Foster-Wheeler, Ltd. for distillation units, etc. for new refinery. Bond issue just authorized by Government

Company	*Head Office*	*Plant Location*	*Daily Cap. (BBL.)*	*Products*	*Remarks*
Venezuela					
British Controlled Oilfields	London	El Mene	65	.....	Topping Plant
Caribbean Petroleum Co.	New York	San Lorenzo	17,000	.....	Skimming and Cracking plant
Colon Development Co., Ltd.	New York	Tarra Field	600	.....	Topping plant
Compania de Petroleo Lago	Caracas	La Salinas	....	.....	.....
Compania de Petroleo Lago	Caracas	La Arriaga, near Maracaibo	1,400	.....	Topping plant
Standard Oil Co. of Venezuela	New York	Caripito	4,000	.....	Topping plant
Tocuyo Oilfields of Venezuela, Ltd.	London	El Mene	250	.....	Topping plant
Yugoslavia					
The Anglo Jugoslav Petroleum Co., Ltd.	Zagreb	Caprag, on the Kupa River	1,500	Complete line except asphalt and vaselines	Battery of stills
Dravogradska Rafinerija Mineralnega Olja	Dravograd	Dravograd	150	Complete line except asphalt and vaselines	Distillation plant
"Ipoil" Dr. Ivanovic & Co.	Osijek	Osijek	500	.....	.....
Standard-Vacuum Oil Co. of Jugoslavia, Inc.	Zagreb	Bosanki Brod	2,000	Complete line	.....





Experimental polymerization unit being operated by Phillips Petroleum Company

Economic and Technical Aspects of Polymerization

The Conversion of Hydrocarbon Gases into Premium Motor Fuels is Viewed in the Light of Other Gasoline Production Methods and its Possible Economic Rôle. By E. Ospina-Racines

THE PAST decade has witnessed remarkable developments in the petroleum refining industry. These are represented by the advent of the multiple fractionating bubble-tower and pipe still, the cracking process, the hydrogenation of heavy oils and today the latest and very promising polymerization process for the conversion of gases into liquid motor fuels.

Notable developments may also be seen in the motorized transport of every nation. The wider and more diverse application of the aeroplane and motor car both for civilian and military purposes has not only increased the number of motor conveyances but it has also brought about the design of the modern high-compression engine. This has resulted in a growing demand for motor fuels and the performance requirements of these have called for gasoline of unprecedented specifications. Today gasoline of high volatility and non-detonating properties is the prime motor fuel and represents 50 percent of the refinery products. As such it becomes the dominant economic factor of the petroleum industry.

Refinery technology in response to growing motor fuel demand introduced the cracking process by means of which the gasoline yield has increased from 18 percent in 1914 to the present average of 44.5 percent per barrel of crude oil. The acceptance of cracking was an economic necessity because of the large proportion of by-product fuel oil. Today its application is due not only to the above fact but because, by an unusually fortunate circumstance, cracked gasoline has proved exceptionally suitable as a motor fuel in view of

its excellent non-detonating properties when used in the modern high-compression engine.

The advent of the polymerization process as the latest technical development in refining is a parallel instance inasmuch as it is a means of converting hydrocarbon gases which are a low value by-product into liquid motor fuel. This development is of special significance to the industry because it taps new sources of motor fuel and the product possesses a high octane rating.

The comparison between cracking and polymerization will be further extended because the technical aspects of these two gasoline production methods offer contrasting views of considerable interest.

The nature of the polymerization process may be explained first by noting briefly the hydrocarbon constituents of crude oil. In petroleum oils four primary types of hydrocarbons may be identified, namely the paraffins or completely saturated hydrocarbons whose very name implies they possess little chemical affinity, the olefines or unsaturated hydrocarbons which are chemically very active, the aromatics possessing a stable cyclic or ring structure and the naphthenes or cycloparaffins whose properties are best interpreted by viewing them as paraffin compounds having a ring structure.

The paraffin and cycloparaffin or naphthenic compounds make up by far the largest proportion of the hydrocarbons present in crude oil, while certain crudes carry small percentages of aromatics. The primary constituents of natural gas are the saturated paraffin hydrocarbons.

The nature of the polymerization reaction may be best elucidated by contrast. Whereas cracking of oil serves to rend asunder the hydrocarbons of high molecular weight, such as are present in the fuel oil distillates, polymerization on the other hand is a synthesis reaction whereby low molecular weight hydrocarbons are converted to high molecular weight compounds. Polymerization of hydrocarbons refers to the synthesis of the same type of molecule into a substance whose molecular weight is a multiple of the original material. In carrying out the polymerization process not only does this phenomenon take place but in addition a condensation reaction is obtained. The latter is likewise a synthesis, where carbon atoms combine to form a higher molecular weight substance. In both instances they are addition reactions and polymerization may be viewed as a particular type of a condensation reaction.

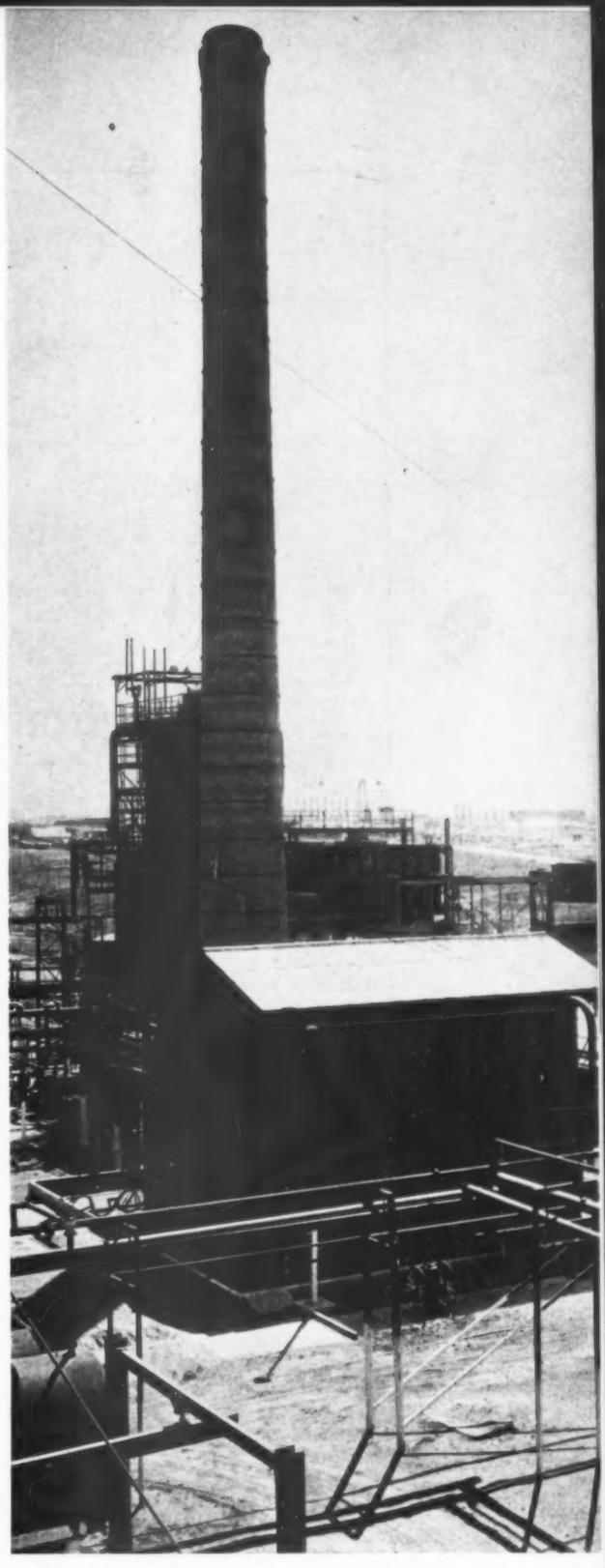
While decomposition of hydrocarbons may proceed regardless of the nature of the hydrocarbons present the polymerization of these when subjected to the proper conditions is limited to the unsaturated hydrocarbons inasmuch as it is only these that can give rise to the polymerization or to the condensation reactions. If the charging stock is composed of paraffin hydrocarbons, or saturated type, cracking must precede the polymerization process. This step of converting saturates into unsaturates may be carried out catalytically or thermally and simultaneously in the process. From this consideration arises one of the limitations of the polymerization of gases into liquid fuels.

Polymerization may be carried out by various agencies. Unsaturates will polymerize under the single or combined influences of heat, pressure, chemical reagents such as sulphuric acid, electric discharge, cathode rays, sunlight, and in the presence of active and inert substances which act as catalysts. The role of catalysts is one of the most interesting phenomena of chemistry and in connection with this refining development it offers the most promising field of research.

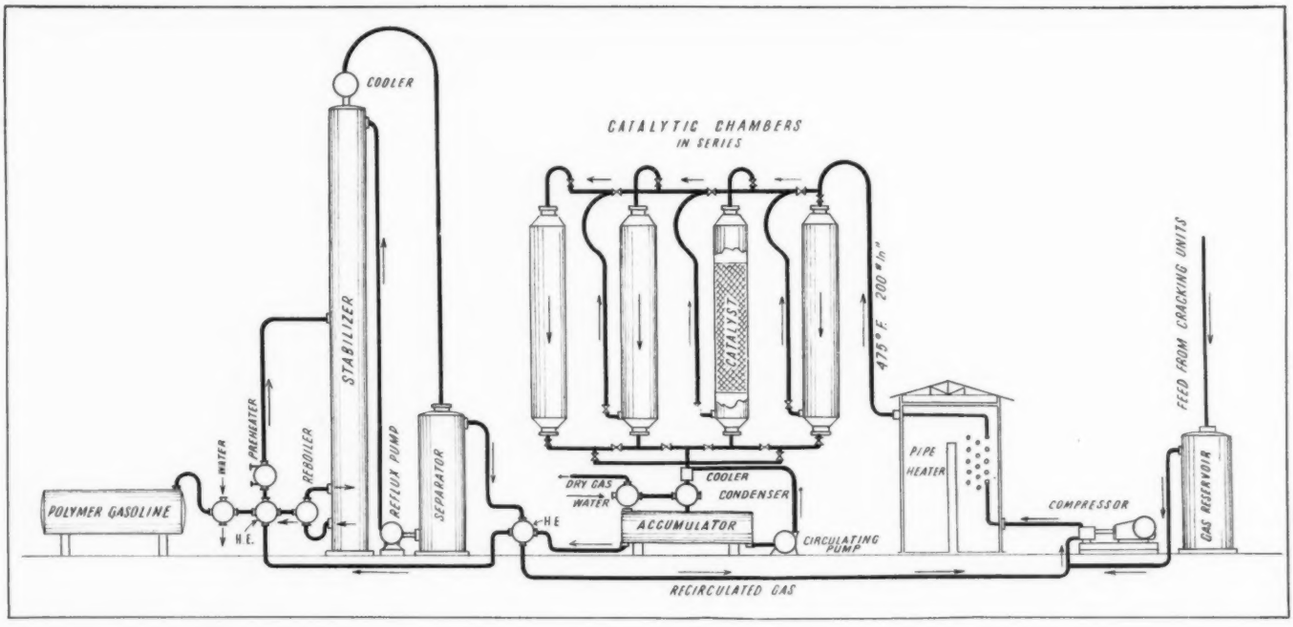
Catalysts are substances which are present during the reaction but do not appear in the end product. These may be nickel, copper, iron or their oxides, sodium, magnesium, platinum, aluminum chloride, phosphoric acid, etc. The presence of one or a combination of these substances brings about the desired chemical transformation. One of the particular advantages in the use of catalysts is the fact that notably lower temperatures are resorted to in the process. Some of the disadvantages in their use arise from the gradual diminishing activity which they undergo and the experience that often they are attacked, particularly by sulphur and its compounds, rendering them completely inactive. One of the methods in offsetting the poisoning effect of sulphur is to use a sulfide of the metal as catalyst. Reactivation is sometimes and frequently possible but eventual replacement of the catalyst is necessary.

Altbough there is a variety of influences to bring about the polymerization reaction, as yet, only heat and pressure and the use of catalysts have any promise or commercial significance.

As may be appreciated from the above the reactions of polymerization and cracking may be produced by the same agencies and in subjecting hydrocarbons to elevated temperatures these reactions often may and do occur simultaneously. Oil distillates when subjected to cracking conditions are not decomposed exclusively but other reactions take place, notable among which are polymerization and condensation. Evidence of these are present in the analysis of cracking still gases. The high antiknock value of the gasoline distillate may be attributed to some extent to these reactions, and the heavy residuum is primarily the condensation of high molecular weight hydrocarbons.



Commercial polymerization unit of the Phillips Petroleum Company at Borger, Texas.



Flow diagram of a catalytic polymerization unit.

The polymerization of gases into liquids has been studied by many distinguished workers. As early as 1866 Marcelin Berthelot of France reported the remarkable transformation of acetylene, which is a highly unsaturated and active hydrocarbon, into a liquid which was predominantly benzene. In one instance as much as 97 percent of the gas was converted by the application of heat. Subsequent investigators are numerous and their nationality is wide in scope. Indeed, the foundations and development of this process are truly international.

Polymerization processes for the conversion of hydrocarbon gases into liquid motor fuels have been announced by the Standard Development Company, Phillips Petroleum Company, The Texas Corporation and the Standard Oil Company of Indiana in the formation of the Polymerization Process Corporation for the purpose of exploiting the combined patents of these organizations in this new refining field. Other organizations which have been prominently identified with this latest development and have announced particular processes are the Universal Oil Products Co., the Anglo-Iranian Oil Company, and the Pure Oil Company associated with Alco Products Inc. of New York.

Research has led to the development of several types of processes which may be conveniently categorized as follows:

1. High Pressure—Polymerization of hydrocarbons under pressure in the range of 200–2000 lbs. per square inch and from 800 deg. to 1000 deg. F.
2. Low Pressure—Polymerization of hydrocarbons under pressures from 50–200 lbs. per square inch and temperatures ranging from 950 deg. to 1500 deg. F.
3. Catalytic—Polymerization of hydrocarbons under pressures of 150–200 lbs. per square inch and temperatures around 450 deg. to 500 deg. F.

The raw material which furnishes the unsaturates may be derived from various sources. The chief source is the cracking still gases and it is principally the interest in converting these into liquid motor fuels that is responsible for this new development. Research has been carried out using natural gas as the raw material but as yet not very promising results have been obtained from a commercial point of view.

The value of the above gases as raw material for this process is in proportion to their unsaturates or olefine hydrocarbon content. This arises from the fact that these require no pre-treatment. The paraffins must be cracked in order to predispose them for polymerization.

The most valuable raw material of the above is therefore the vapor-phase gases in view of an average olefine content of 53.0 percent and the second important source is liquid-phase gases with 16.8 percent of unsaturates. Although natural gases contain no olefines, its great abundance in certain localities and relatively lower cost make this a possible source in conjunction with previous cracking of the gas. As may be noted, other sources such as cracking of tars, low temperature carbonization and also retorting of oil shale might be considered in view of their olefine hydrocarbon content. Their cost in comparison to the first three sources of raw material does not make these possibilities attractive for the present.

A catalytic polymerization unit is illustrated in the accompanying diagram. In general, the thermal processes have the same design but the operating conditions, as previously noted, are altered. The conversion of the cracking still gases is as follows: The gas is delivered by the compressor to the pipe-heater, whence it proceeds to the catalytic chambers (which are connected in series) in a downward direction. These may also be used in pairs provided the time is of sufficient duration. The accumulator receives the product which is cooled by the circulation of condensed product and further by the water condenser. The dry gas and liquid product are removed. The latter is directed to the stabilizer which takes off the more volatile components and dissolved gases of the gasoline. The bottoms from the stabilizer are directed to the cooler and then to the crude polymer gasoline drum. The gases from the stabilizer are recirculated.

Available reports from various processes disclose a yield of polymer gasoline from 3 to 12 gallons per 1,000 cu. ft. of gas. About 4 to 6 gallons are the best yields for blending. The gasoline has a tolerable sulphur content when the feed gas is previously scrubbed and the gum content ranges from 4 to 44 mg. per 100 cc. By the A.S.T.M. method it is not higher than 8 mg. per 100 cc. The induction period

is relatively short, around 35 minutes, but by proper inhibitors it is readily raised to as high as 1,100 min. The Reid vapor pressure ranges from 9 to 14 lbs., so in a blend it is not likely to promote volatility.

The outstanding property reported is the high octane blending value. Although the octane value of the crude gasoline itself is predominantly around 78–82, in a 25 percent blend it imparts non-detonating properties to the solution equivalent to having an original 100 to 125 octane value. The thermal processes may produce a gasoline of 100 octane value or more and of high volatility but this is carried out at the expense of a quantity yield of as much as 25 percent to 50 percent.

To obtain maximum yields the primary factors of the processes are the temperature at which the process is carried out; the time during which the charge is subjected to the conditions; the concentration of the unsaturated hydrocarbons; the presence of active catalysts.

The temperatures are as noted before, but their control requires special attention because, unlike the cracking reaction which is an endothermic process, the polymerization is an exothermic one. High pressures are favorable to the reaction inasmuch as the synthesis results in a reduced volume. The time reported varies from 40 to 200 seconds, the latter being more favorable to yields of 4 to 6 gallons per 1,000 cu. ft. The concentration of the olefine hydrocarbons is the principal controlling factor in obtaining high yields. When charging relatively pure unsaturated hydrocarbons a conversion from 86 percent to 99 percent may be obtained. However, the concentration of the cracking still gases provides only from 15 percent to 55 percent, and in view of this dilution, the conversion is considerably reduced necessitating recirculation from 1 to 4 times.

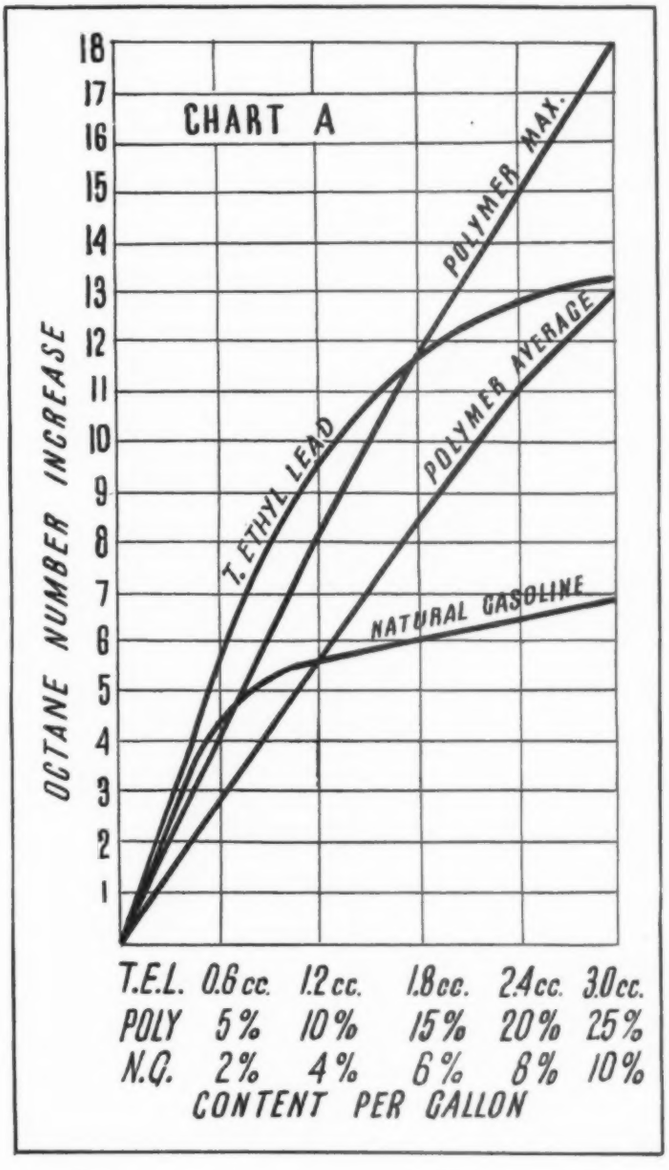
While most gases from cracking stills may be used directly as charging stock it is more advantageous to exclude as much as possible the very volatile or low molecular weight paraffins and hydrogen, and to concentrate the liquefiable hydrocarbons. This may be accomplished either by absorption or by high pressure rectification at about 400–500 lbs. per square inch. Charging of high molecular weight hydrocarbons will reduce the total volume throughout, reduce operating costs and result in much higher yields.

The utilization of natural gas as raw material is attended by many technical difficulties. The largest proportion, from 86 percent to 90 percent, of the paraffins present in natural gas is methane. The polymerization of this hydrocarbon can only be attained by resorting to temperatures around 1800 deg. F. and having the gas flow at a high velocity through the reaction chamber. A large quantity of heat is required and the best yield as yet reported is 1.44 gal. per 1,000 cu. ft.

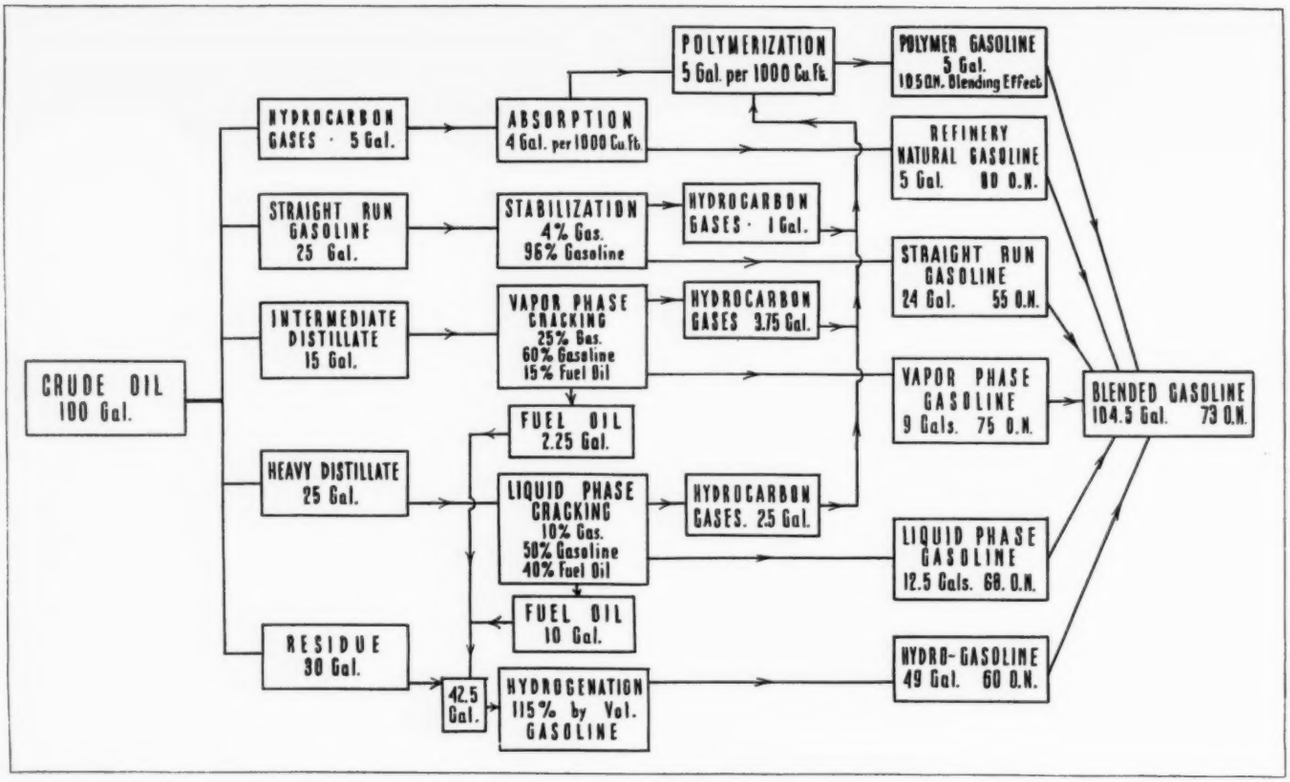
Catalytic polymerization offers the most promising field of development and in view of the moderate operating conditions both of temperature and pressure which result in yields from 3.5 to 8 gallons per 1,000 cu. ft. and the possibility of discovering more active catalysts, this phase of polymerization may be considered the most attractive and promising field of endeavor.

The economic role of this process must be viewed in the light of other gasoline manufacturing production methods. For convenience the chart (on page 620) depicts the various refinery developments, together with their present average yields when processing crude oil for maximum of gasoline production. Although not entirely profitable as yet to carry out the above, it shows the possibility of converting a crude barrel of oil into a greater volume of gasoline. The advent of polymerization completes the cycle of conversion.

On the left, 100 gallons of crude oil by fractional distillation will yield on the average the primary products and amounts as indicated. These are further processed for ultimate gasoline production. The straight-run gasoline is stabilized, the



Comparative value and quantity of various agents for increasing octane number.



The place of polymerization in various methods of refining.

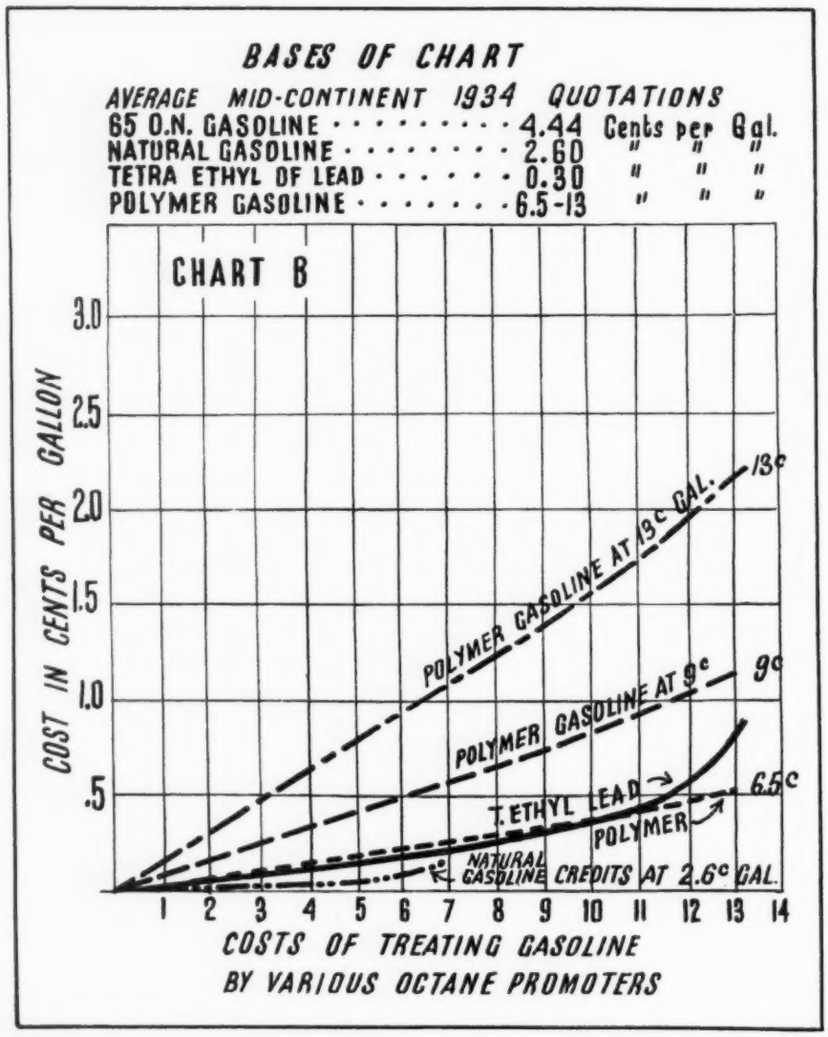
fuel oil distillates are cracked in vapor and liquid phase processes respectively.

The yields from these are shown in percentage of charge. These give 9 and 12.5 gal. of high octane gasoline. The fuel oil derived from these operations is combined with the 30 gal. residue, giving 42.5 gal. of charge to the hydrogenation unit. The latter produces 115 percent by volume of gasoline or 49 gal. of 60 octane number motor fuel.

The gases derived from the stabilizer together with the cracking still gases pass to the polymerization unit. On the bases of 1,000 cu. ft. and 600 cu. ft. of gas derived per barrel of oil charged from vapor and liquid phase cracking respectively, 930 cu. ft. are obtained. When polymerized, this yields some 5 gal. of gasoline. The final blend of these gasolines will give 104.5 gal. of 70–73 octane value.

This illustrative chart represents but one of several methods of treating crude oil. With three different processes for treating the fractions below the intermediate distillate it is possible to have six combinations. Moreover, for the sake of clarity and simplicity, stabilization of gasoline has been applied to the straight-run product and is used merely to illustrate this intermediate step as a source of hydrocarbon gases. The chart shows that the yield of polymer gasoline will be on the average 5 percent of the total gasoline eventually produced. Absorption yields about the same quantity per 1,000 cu. ft. as polymerization. Hydrogenation of oil promises the largest proportion for the future, or about 50 percent. For 21.5 gal. of cracked distillate and 24 gal. of straight-run gasoline only 5 gal. of polymer may be expected or about 1 to 9 ratio.

The outstanding merit that polymerization can claim is not that it will offer an abundance of motor fuel from new sources but that its product, when used in blending, imparts high non-detonating properties to the blend. The gasoline manufacturing processes offer quantities that may be termed inversely proportional as the octane rating of their product.


BASES OF CHART
AVERAGE MID-CONTINENT 1934 QUOTATIONS
65 O.N. GASOLINE · · · · · · · · · · 4.44 Cents per Gal.
NATURAL GASOLINE · · · · · · · · · 2.60 " " "
TETRA ETHYL OF LEAD · · · · · · · 0.30 " " "
POLYMER GASOLINE · · · · · · · · 6.5-13 " " "
CHART B
COST IN CENTS PER GALLON
3.0
2.5
2.0
1.5
1.0
.5
POLYMER GASOLINE AT 13c GAL.
13c
POLYMER GASOLINE AT 9c
9c
T. ETHYL LEAD
POLYMER
6.5c
NATURAL GASOLINE CREDITS AT 2.6c GAL.
1 2 3 4 5 6 7 8 9 10 11 12 13 14
COSTS OF TREATING GASOLINE
BY VARIOUS OCTANE PROMOTERS

Cost of increasing octane rating by the use of various agents.

The polymer figure in the following table is based on the production of 182,443,000 bbl. of cracked gasoline, being 44 percent of the charge and assuming 600 cu. ft. of gas per barrel of charge and a conversion factor of 5 gal. of polymer gasoline per 1,000 cu. ft.

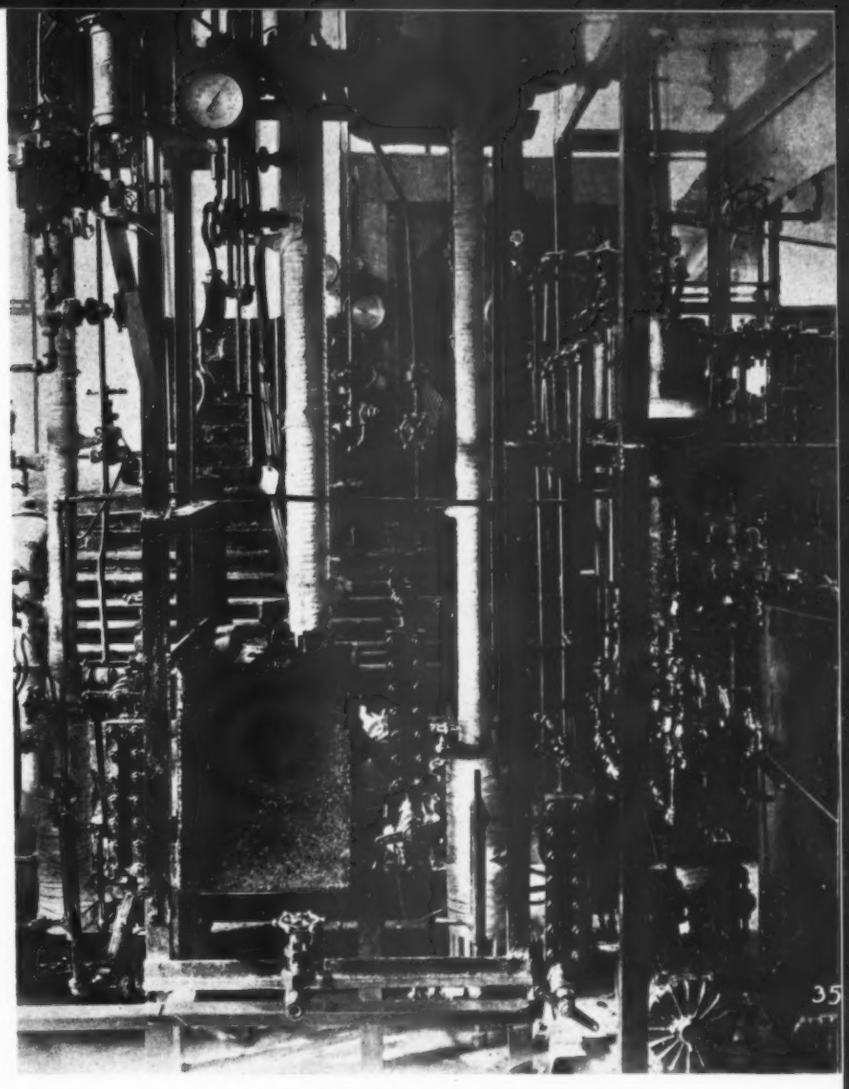
From the above it may be appreciated that polymer gasoline will not furnish a large proportion of future motor fuel.

As an agent in promoting the octane value of gasoline it must be considered in relation to other agents, namely natural gasoline and tetraethyl lead. In the chart (on page 619) this property is contrasted and both the maximum and average blending curves are given.

The maximum T.E.L. (tetraethyl lead) per gallon allowable is 3.0 cc. and for natural gasoline a 10 percent blend is taken as the maximum inasmuch as higher percentages will result in a Reid vapor pressure exceeding current specifications. A 10 percent blend will give about 11 lbs. R. v. p. or just above the average of 8 lbs. for summer and 12 lbs. for winter conditions. The maximum polymer is taken as 25 percent in a blend since as will be shown later, greater proportions are not economically feasible if the cost of this product exceeds 6.5 cents per gallon.

Some of the interpretations that may be gathered from this graph are that the maximum quantity of these agents per gallon of blend will raise the octane value of the solution as follows: 13.2 numbers when 3.0 cubic centimeters of T.E.L. are added, 13 numbers when the average polymer effect is taken for a 25 percent blend, and 18 numbers when the highest effect is obtained. The latter is obtained in low octane value or straight-run gasolines primarily. Natural gasoline will raise the octane value only 6.9 numbers when present as a 10 percent blend. Other conclusions that may be observed are that a 10 percent blend of polymer gasoline will increase the octane value 5.5 numbers, whereas only 4 percent of natural gasoline is required and for the same increase only 0.6 cc. of T.E.L. is needed.

The polymer curve shows a steady trend while natural gasoline and T.E.L. diminish in their activity as the concentration is increased. The former reaches its peak at about 5.5 numbers and the latter at about 11.5 numbers.



A small experimental polymerization unit used by M. W. Kellogg Company for research work.

On a volume basis T.E.L. is extremely potent. One U. S. gallon is equivalent to 3,785 cc. For the same octane rise of 5.5 numbers only 0.6 cc. of T.E.L. is required or 378.5 cc. of polymer gasoline per gallon of blend and 151.4 cc. of natural gasoline per gallon of blend. In other words lead is 631 times more active in this respect than polymer and about 252 times more than natural gasoline. Of course, the addition of T.E.L. does not increase the amount of gasoline, whereas in the use of the latter two agents a volume credit is obtained.

It would seem that the role of polymer gasoline is more evident in treating low octane number or straight-run gasoline. In this way the greatest effect is obtained; it offsets reforming operations and adds a premium to the low value stock.

An economic comparison of these agents when used per gallon is shown in chart B. Tetraethyl lead costs 3 mills per cubic centimeter, natural gasoline had an average Mid-continent quotation in 1934

Figures for 1934 Gasoline Production

Product	1934 Thousand Barrels	Octane Rating	1934 Percent of Total	Percent with Polymer
St. Run Gasoline	206,486	55	48.5%	45.5%
Cracked Gasoline	182,443	68	42.8%	40.0%
Natural Gasoline	36,217	80	8.7%	8.0%
Polymer (Possible)	29,500	80–100		6.5%

Typical Analyses of Gases From Various Sources

(Percent by Volume)

Constituent	Liquid-Phase Cracking	Vapor-Phase Cracking	Natural Gas	Cracking Coal Tar	Low Temp. Carbonization of Coal
Paraffins	80.2	39.6	95.0	65.9	35.0
Olefines	16.8	53.0	....	5.6	4.5
Hydrogen	3.0	7.0	....	11.3	45.0
Non-Hydrocarbons	....	0.4	5.0	17.2	15.5
Cost at Plant per 1,000 Cu. Ft. in cents	15.0	15.0	6.5	25.0	40.0

of 2.60 cents per gallon and gasoline of 65 octane number was quoted at 4.44 cents. The cost of polymer gasoline is taken as 6.5 cents to 13.0 cents per gallon. These latter figures are used merely to contrast the cost of the agents rather than to set a price for the product. It is assumed that the addition of the respective percentages of polymer and natural gasolines does not result in a diminution of volume. The average polymer effect is taken for comparison.

The T.E.L. curve and the polymer curve almost coincide, when the latter's cost is 6.5 cents per gallon. Up to 11 octane numbers the increase of cost per gallon is about the same. From this figure to 13 numbers polymer gasoline is cheaper, inasmuch as T.E.L. diminishes in its effect and its cost almost doubles to 0.9 cents. Above 6.5 cents the cost of polymer treatment is greater except when the octane increase is around 11 to 13 numbers. For the maximum effect of 13 numbers the cost will be 0.9 cents per gallon of blend when polymer is quoted at 8.04 cents per gallon. The latter figure is apparently the competing limit for polymer versus T.E.L.

The use of natural gasoline is limited to a rise of 7 octane numbers. Since its quotation of 2.60 cents per gallon is less than the 4.44 cents quoted for the gallon a credit is obtained rather than an added cost. However, a diminution of volume will most likely offset this credit. Its use is primarily for volatility.

The above chart may be made clearer by explaining the bases. Adding T.E.L., no increase in volume is obtained. The cost is therefore directly additive. On the other hand, if the gallon sells for 4.44 cents and contains 25 percent polymer gasoline only 1.11 cents are realized for this 25 percent, whereas its cost is 1.625 cents at 6.50 c. per gal. The net cost is therefore 0.515 cents per gallon for a 25 percent blend. In the case of natural gasoline the credit is 0.44 cents realized on 10 percent of the gallon, whereas its cost is 0.26 cents, therefore giving 0.18 cents net credit for the maximum natural gasoline blend.

In view of the fact that gasoline below 60 octane number was quoted at the average of 3.63 cents during 1934 and the premium gasoline of 65 octane number at 4.44 cents the difference between these figures provides a margin of profit that can offset the cost up to 0.81 cents per gallon.

It would seem, therefore, more profitable and economical to treat straight-run gasoline of 60 octane and below with polymer and place the blend in the premium grade, reserving T.E.L. treatment for the higher octane gasolines.

Thermal Polymerization of Gaseous Hydrocarbons

*By W. W. Gary**

THE POLYMERIZATION Process Corporation has recently announced a process for the thermal polymerization of gaseous hydrocarbons. This process is the result of research and development on both catalytic and thermal investigations, and while the results of research indicate that both catalytic and thermal processes may be employed, the thermal process has been selected for presentation to the industry by reason of its more general application, its higher yields of motor fuel per unit of charge, and its actual commercial application on a large scale.

The polymerization of gaseous hydrocarbons to produce liquid motor fuels is divided into two classes, namely, catalytic and thermal. For several years, both types of processing have been the subject of extensive research.

Until quite recently the gaseous hydrocarbons of the petroleum refining industry have been used primarily for fuel purposes in processing. However, in the past few years the results of research and commercial development have proved that these gaseous hydrocarbons may be used advantageously for the production of motor fuels of superior quality. In addition, it has been found that thermal polymerization is commercially practical for the treatment not only of gaseous hydrocarbons from refineries, but also of gases produced coincident with the production of crude petroleum.

The catalytic polymerization process, as the name implies, depends upon catalysts as an aid to the reaction, while thermal polymerization is accomplished by heat and pressure alone. With catalysis, the gaseous hydrocarbons susceptible to reaction are confined to the unsaturated type, while with the thermal process the material susceptible to reaction includes both the unsaturates and the saturates. This fact is extremely important commercially, for the reason that both refinery and natural gas hydrocarbons consist mainly of the saturated type.

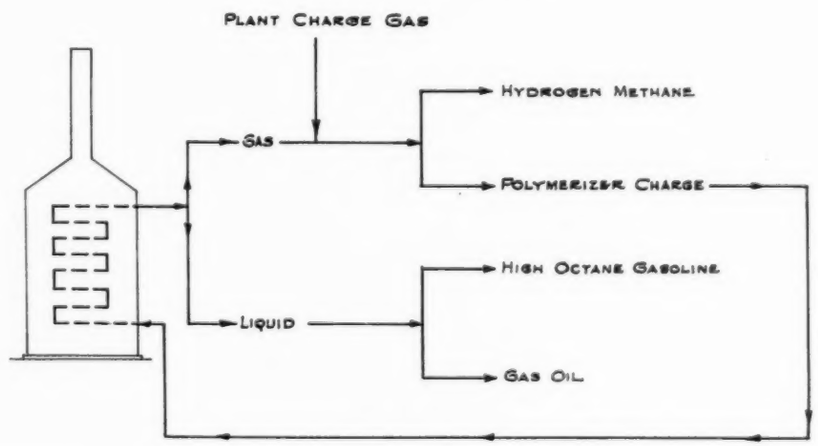
Gaseous hydrocarbons normally produced from the refining or production of petroleum comprise essentially the following:

Hydrogen
Methane
Ethane
Ethylene
Propane
Propylene
Butane
Butylene

The charging stock to the polymerizing zone of a thermal polymerization plant consists primarily of any or all hydrocarbon gases containing two carbon atoms or more. Selection of the most desirable fractions of the total gas is mainly a problem of fractionation and economics.

The operating conditions for thermal polymerization are a function of the charging stock composition, and therefore vary over a considerable range. Generally speaking, the limits are confined to

Flow chart of a thermal polymerization plant.



*Engineer of the M. W. Kellogg Company which has been appointed licensing agent for The Polymerization Process Corporation for the United States and foreign countries.

from 1,000 to 3,000 lb. pressure, and temperatures from 950 deg. to 1,100 deg. F. Heating and reaction time must be carefully selected and controlled.

The basic principles of processing are shown in the accompanying flow chart. The charge gases are compressed, if in a gaseous state, or pumped, if liquefied, into the polymerization plant fractionating equipment. The hydrogen and methane and a portion of the ethane are discharged from the equipment, and the higher molecular weight gases, including both the fresh feed and the recycle, are charged into the polymerizer and treated under pressure and temperature conditions within the limits described.

The discharge products from the polymerizer comprise hydrogen and methane, recycle (higher molecular weight gases), gasoline, and a trace of gas oil. This mixture, in combination with incoming fresh feed to the unit, is fractionated under pressure and the hydrogen and methane removed from the plant as fuel gas, the recycle returned to the polymerizer, and the gasoline distilled to end point.

The characteristics of the polymerized gasoline are of special interest for the following reasons: (1) the boiling range exhibits excellent volatility; (2) it is a stable product; (3) it is not gum forming, and is readily refined with light clay or acid treatment; and (4) the octane value is extremely high.

Typical Specifications of Commercially Produced Polymer Gasoline

A.P.I. Gravity	60 to 64 deg. F.
Initial Boiling Point	94 deg. F.
20 percent	140 deg. F.
50 percent	170 deg. F.
90 percent	330 deg. F.
End Point	400 deg. F.
Octane blending value with respect to Reference Fuel A	80 to over 100
Saturation (acid absorption)	80 to 86 percent insoluble

A large commercial installation operating according to the thermal polymerization method, is located at Borger, Texas, at the plant of the Phillips Petroleum Company, and has been in successful commercial operation for a considerable period of time, producing polymerized gasoline in daily volume up to 1,000 bbl. No operating difficulties have been experienced and the operating time efficiency has been of the magnitude of 95 percent on stream. The charging stock to the commercial unit has varied from 100 percent gaseous fractions from refinery cracking plants to 100 percent gases with source from natural gas. Over this range of charging stocks the unsaturation of the charge has varied from 1 percent to approximately 40 percent.

Experimental pilot plants for the purpose of research and commercial design have been operating in the plants of the Phillips Petroleum Company, the research laboratories of The M. W. Kellogg Company, Standard Oil Company of Indiana, Standard Oil Company of New Jersey, and The Texas Company. Basic information derived from these experimental pilot plants has been instrumental in the rapid commercial development and application of thermal polymerization.

The commercial operating costs of thermal polymerization are dependent upon (1) the value of the gases charged to the unit; (2) the size of the thermal polymerization plant; and (3) the value of utilities used. Even in localities of higher utility rates, the operating costs of thermal polymerization have been proven to be very low. The operation is sufficiently simple to require a minimum personnel for operation and maintenance. The plant may be considered comparable in simplicity to that of a normal cracking and stabilization unit.

The investment cost of a thermal polymerization plant varies considerably with the local conditions of application. In cases where cracking or fractionating equipment are available within a refinery, certain parts of the polymerization plant may be combined with existing equipment. For this reason, each application of thermal polymerization is a special refinery or field study.

A large application of thermal polymerization lies in the field of natural gas manufacture and production. Thermal polymerization in this instance is extremely economical, due to the fact that valuable motor fuel is produced from what is at present substantially a waste product.

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Cracking's Contribution

(Continued from page 580)

the straight-run gasoline and naphtha fractions with equal facility into high antiknock motor fuel.

In the early days the only mission of the cracking process was to produce salable gasoline and it was taken for granted that was all it could do. A certain percentage of the gas oil which originally was the only suitable cracking stock was ennobled into gasoline, while the remainder, the greater percentage, was degraded to the point of practical worthlessness. But today there is a different story.

Hand in hand with the development and research work that adapted the process to crack all kinds of oil, went work to make it possible, while obtaining the maximum yield of cracked gasoline, at the same time to make salable secondary products that stand on their own feet in the market and give the sales manager an additional chance to show a profit.

High-grade asphalt and road oil, special hard, low volatile coke, furnace oil, Diesel and special quality cracked fuel oil are some of the secondary products of cracking that are adding to refiners' earnings.

So the reason for the refiner's second revision of his estimate of the cracking process was the proved fact that the value of all the oil put through a modern cracking unit can be increased, instead of a part being enhanced in value and the remainder degraded.

Work to improve still further the versatility of the cracking process and the quality of its products is in the hands of a notable staff of technologists and is going forward with increasing diligence and unflagging vigor.

Another forward step that has been taken to make cracking more profitable is the development of a liquid inhibitor to prevent the formation of gum in cracked gasoline. This alone is saving millions of dollars a year to refiners.

Today in many refineries gasoline from the cracking unit is treated with a very small percentage of inhibitor and is then ready for shipment.

Today a cracking unit is recognized as an essential feature of the well rounded and efficient refinery. Data supplied by the Universal Oil Products Company show that thirty-one Dubbs cracking units have been installed during the past two years, or are now under construction or contracted for in the United States, Canada, South America, Europe, and Asia.

The recent installations made by this one company by no means measure the extent to which cracking has spread. As articles previously published by WORLD PETROLEUM show there are a number of patented methods covering the cracking operation and there are a few well-known processes in extensive use. The record in this one case, however, is significant of the importance that cracking has come to occupy in the refining industry. The list of recent installations is particularly significant of the growing recognition by refiners of the value of cracking straight-run gasoline by reforming.

Cracking has by no means reached the limit of its possibilities but its record to date has demonstrated that it is the most significant and, from the consumer's point of view, the most beneficent advance in the refining art in recent years.

Refractories for Oil-Fired Furnaces

Insulating Materials That Conserve the Useful Heat of the Fuel Improve Performance and Save Many Times Their Cost

By J. G. Coutant

International Fuel Engineer

WHILE careful study and exhaustive tests have been applied to furnace construction to the end of obtaining the most complete combustion of the fuel used too little attention has been given to the loss of heat through the refractories used. Often one type of furnace is pronounced inferior to some other when the real reason for the deficiency may be traced to the insulating refractories employed. In the attempt to throw some light on this little considered subject the following remarks are made.

Fortunately the difficulties arising on this score can be overcome in most cases without expense to owners, as insulating refractories, such as tiles, brick and concrete as compared with fire-clay refractories, are to be regarded as an investment. Repeated tests show a return of 400 to 800 percent on the cost of relining oil-fired furnaces with Insulbrix and Insulcrete, the return being derived from the saving in fuel based on operating 300 eight-hour days per year.

The special feature of these materials is that they imprison the useful heat of the fuel until it is utilized for heating metal in the furnace or reflecting it to the boiler tubes. This increases output, saves fuel, lowers plant investment and betters working conditions in furnace rooms.

Advantages from the saving of useful heat in oil-fired furnace operation may be summarized as follows:

The furnace can be lighted and put out at will without incurring a noticeable loss of time or fuel. This is a condition that cannot be duplicated with fire-clay refractories.

There is an increased liberation of heat per cu. ft. on combustion due to the higher amount of radiant heat which is reflected at a greater rate, both acting to accelerate ignition and velocity of combustion.

In average furnace operation there is a 200 deg. F. increase in flame temperature.

The increase in heat reflected to metal or boiler tubes is 20,500 Btu. per sq. ft. per hour when furnace is operating at 2,750 deg. F.

Thermal efficiencies are higher, due to the greater absorption of radiant heat which lowers the exit gas temperatures.

Boiler furnaces attain their maximum thermal efficiencies about the moment they are put on the line and unaccounted losses are lowered due to the lessened heat storage in refractory walls.

The furnace is sensitive to temperature control and meets fluctuating loads as quickly as the control apparatus can change the fuel and air supply.

Due to increased temperature the furnace output may be doubled. Double the useful heat head and the output will double.

Insulating refractories increase temperatures more than ordinary air preheaters, which are an expense.

Furnace metal losses may be reduced 50 percent in metallurgical furnaces.

Weight is reduced and furnace room conditions are bettered. Insulbrix or Insulcrete lined furnaces can be placed in the route of production or furnaces can be moved and the work furnace rooms are no longer necessary.

Increased combustion space and larger hearth areas are possible because the walls are thinner.

It may be worth while to define the term useful heat used in the foregoing. It is the amount of heat available between the temperature that can be obtained by the products of combustion and the temperature of the metal, hearth or exit gases of the furnace.

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Oil in America's Hour

"THE COUNTRY which dominates by means of oil will command at the same time the commerce of the world. Armies, navies, even entire populations, will count as nothing against the lack of oil."

The words are those of Elliot Alves, oil expert of England. More succinctly put was the short phrase uttered by Henry Berenger, the French diplomat:

"Who has oil . . . has Empire!"

Both statements were included in a dramatization of oil and the industry that has developed from it, heard over the Columbia Broadcasting System on August 11. The program was fourth in a series of Sunday night broadcasts known as AMERICA'S HOUR. Composed of short dramatic sketches and using monologue for continuity, the curious story of oil was traced from a period six centuries B.C. to modern times.

After relating the discovery of a "black, pitchy substance" (bitumen), used by Nebuchadnezzar as an adhesive in building a wall near Babylon, and Marco Polo's use of the mysterious "earth oil" for burning flares, the narrative moves forward to the year 1856 and the experiments of George Bissell and Prof. Silliman, which led to the use of oil for illumination in place of tallow candles. The next step, the drilling of "Drake's folly," was vividly described, sound effects of drilling and the derisive remarks of onlookers being used to good advantage.

The oil boom, the confusion and the accompanying waste of men, oil and materials was emphasized. At this point, of course, John D. Rockefeller entered the picture. As partner in a Cleveland produce commission house looking over the new oil business in Pennsylvania, his reactions to what he saw were given.

"There's too much waste here now," he observed. "Wasted people . . . wasted wells. I'll take an interest in oil when it quits being a game. I don't like games. I like business." At another time, pointing out that "millions are made in a week and lost in a day" he asserted, "When I make millions, I don't plan to lose them."

The early problems of transportation, the introduction of pipelines and the beginning of Rockefeller's career in the refining and distribution of oil followed. Referring to the railroad rates he obtained and his use of these low rates in bending the smaller refineries to his will, Rockefeller explained that "my primary interest in the oil business is to effect as large a distribution as possible at the lowest possible price to the consumer. Oil must

come under some form of centralized head."

The pioneering and marketing methods of American oil salesmen in various countries were described. The discovery of new fields, the resultant overproduction and hot oil were all briefly but vividly dramatized, as were subsequent conservation measures.

The program being one of a series entitled AMERICA'S HOUR, considerable emphasis was naturally placed on the significance and importance of American oil to the Allies in 1918. Clemenceau's cabled plea to Wilson for oil, upon hearing the alarming report that France had less than a month's supply of gasoline left. . . . Wilson's order that a tanker fleet immediately be mobilized and convoyed across the Atlantic. . . . The danger and losses suffered passing through the submarine zone. . . . The revival of spirit in France when the precious cargo was received in time;—Graphically the paramount importance of oil in times of national emergency was emphasized. Nor was the rôle played by oil in international politics overlooked. These last scenes, portraying as they did the World War and the revival of nationalism during the last decade, were extremely timely and forceful as well as dramatic, and did not lack for a moral.

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German Oil Imports Create Exchange Advantages

Value of Oil Imported Into Germany Represents Only 2.6 Percent of Total Imports and Aids Exchange Arrangements. By Dr. Walter Kruspig.*

General Director, Rhenania-Ossag Mineraloelwerke, A.G.

GERMAN consumption of mineral oils, together with their substitutes, amounted in 1934 to 3,500,000 tons. This relates only to the internal consumption, omitting fuel oil bunkered by German ships in ports of other nations.

The major part of this consumption of petroleum is naturally represented by the lighter motor fuels, which amounted to 47 percent of the total. Second place is taken by the heavier motor fuels (gas oils) with 18.6 percent; the proportion of this class is now increasing at the expense of the lighter fuels, due to increased use of Diesel engines. Third place is occupied by lubricating oil, the consumption of which represents 10.4 percent of the total. Then follow fuel oil bunkered in German ports, 9.4 percent; asphalt, a little over 8 percent; lamp oil and miscellaneous products make up about 3.3 percent.

The proportion of petroleum imported to cover the above listed requirements varies greatly according to the class of product. Of the 1,655,000 tons of automobile fuel consumed, about 650,000 tons, or about 40 percent, was derived from various domestic sources, including derivatives from coal and agricultural products. About 80,000 tons was obtained by stripping or cracking domestic petroleum; coal furnished about 250,000 tons of benzole and hydrogenized products, and by grace of the obligatory mixture of 10 percent of alcohol the farmers furnished 170,000 tons of the product of their distilleries. This left 1,000,000 tons of the lighter fuels to be imported.

The situation as regards the heavier motor fuels is somewhat different. Of the 650,000 tons of this grade the German petroleum industry and the brown coal distilleries furnished between 40,000 and 50,000 tons, or about six to seven percent. The other 93 percent originated outside of Germany. The ability of the German industry to supply lubricating oil is somewhat greater and recently has been increasing at a faster rate than the consumption; last year the proportion of domestic lubricants rose to 24 percent, so that, for a total consumption of 360,000 to 365,000 tons, only 280,000 tons of lubricants had to be imported. The German oil industry furnished only 12,000 tons of asphalt which is about four percent of the 290,000 tons consumed.

This variability of the participation of the German oil industry in the domestic trade is due both to technical possibilities and the price structure. The home producers naturally bend most of their efforts to furnish gasoline, the product which has the greatest tariff protection and for which there is the greatest need.

How future German requirements for petroleum will develop and what will be the relative participations of external and domestic sources in meeting these requirements, are open questions. Gasoline consumption will depend on the one hand on the increase in the number of registrations of motor vehicles and on the other hand on what proportion of this increased registration is represented by Diesel-driven units. In view of the increase of these gas-oil consuming units it is not unlikely that total gasoline consumption will show a decrease, notwithstanding an increase in the total number of vehicles.

As regards lubricating oil, increased consumption will also depend on further mechanization of land and air transport, and on the other hand on what progress is made in more economical use and recovery of lubricants; an increase in industrial activity will naturally increase the demand for these indispensable materials.

The major part of German oil imports comes from what is designated in the statistics as "other America," which is practically identical with Venezuela; from this source come 42 percent of imported oil; the share of the United States has now

(*Abridged from an address before the Power Fuel Society and the German Society for Mineral Oil Research at Hamburg, July 1, 1935.)

shrunk to 13.5 percent as a consequence of the unfavorable trade balance; Russia has 13 percent; Mexico, Roumania and Persia have each about 8 to 8.3 percent.

In order to put certain prominent economic facts in a proper perspective it is desirable to consider the heat units of imported oils in relation to their cost, c.i.f. German port. These costs are: 10,000 gasoline calories cost 5 Reichspfennige (2 U. S. Cents); 10,000 gas oil calories cost 3.6 Reichspfennige (1.22 U. S. Cents); and 10,000 fuel oil calories cost 2 Reichspfennige (⅘ U. S. Cents).

The last named price is that of stove coal calories. At these small unit prices for the 2,900,000 tons of imported oil, which supplies power for nearly two-thirds of our motorized vehicles, tens of thousands of tractors, thousands of large and small Diesel engines in all branches of our industry; oil products with which we lubricate four-fifths of our machinery, build our roads and cover our roofs, we pay only RM. 116,000,000 ($46,400,000 U. S.) for the excess of imports over exports. This is exactly 2.6 percent of the entire German imports, and only RM. 7,000,000 ($2,800,000 U. S.) more than Germany pays for imported fruit. With 2.8 percent of its export credits Germany has paid for the imported oil it has consumed, and if there were no domestic oil industry Germany could cover its entire petroleum requirement for 3.8 percent of its export credit. This is about equal to the credits established by our exports of glass.

Naturally, a change in the parity between the dollar and the Reichsmark will change the prevailing price level. As the dollar falls, Germany will pay less for its oil, and the situation can only become better if prices are further lowered by continued improvement in petroleum technology; and since the world price—so far as concerns supply and demand—depends almost exclusively on the United States, American conditions as regards production, consumption and export become of prime interest. But considering one thing with another, it is extremely difficult to foresee future developments, but the general tendency points to a strengthening of prices.

Not all petroleum imported into Germany comes as finished products. Total German imports are naturally greater than German consumption; some is re-exported, and there are manufacturing losses. Gross imports amounted to 3,154,000 tons, of which 1,123,000 tons—more than a third—consisted of crude oil and half-finished products that are further prepared for use in German refineries. According to the statistics 550,000 tons, partly as crude oil and partly as residues, were used primarily for making lubricating oil and asphalt. Among these half-stuffs 280,000 tons of crude gasoline was used as starting material for commercial gasoline, and 170,000 tons of lubricating distillate passed through the German refineries.

Mineral oils arriving in Germany have to cross a high tariff wall, which adds RM. 22 ($8.80 U. S.) to the Hamburg price of gasoline, making the wholesale price to German consumers RM. 28 per 100 kg ($112.00 U. S. per ton). By the same means RM. 12 ($4.80 U. S.) is added to the cost of lubricating oil, and gas oil (Diesel fuel) costs RM. 4.80 ($1.92 U. S.) more than the world price. The first result of the arrival of imported petroleum in Germany is therefore a substantial contribution to the government finances; in 1934 this contribution amounted to between RM. 280,000,000 and RM. 290,000,000 ($112,000,000–$116,000,000 U. S.), which is a good fourth of the total tariff revenue.

With one exception the domestic retail price is determined by the world price plus tariff. This exception is fuel oil, on which the tariff rate is absolutely prohibitive; hence no imported fuel oil is used in Germany and the price of fuel oil of German origin, including that from the stove coal and the brown coal distilleries, is determined by the price of competing German fuels. The general result is that in 1934, German oil consumers paid RM. 900,000,000 ($280,000,000 U. S.), which was about RM. 500,000,000 ($200,000,000 U. S.) more than the world price. Of this 500,000,000 the government treasury took between RM. 280,000,000 and RM. 290,000,000 ($112,000,000–$116,000,000 U. S.); the difference here is chargeable to the higher production cost of German oil, and in which is included the RM. 95,000,000 ($38,000,000) imposed by the enforced mixing of gasoline with alcohol.

As the German Minister for Transportation has pointed out, there can be no hope for lower domestic prices for oil until the domestic oil industry is able to lower its production costs and is thus able to bear a larger share of the public tax burden so as to permit a lowering of the oil tariff.

The desirability of lowering these costs may be illustrated by the following example: An omnibus that makes a trip of 100 kilometers (62.1 U. S. miles) on 30 liters (6.82 U. S. gal.) of gasoline would need to spend only RM. 1.40 ($0.56 U. S.) for fuel if gasoline could be bought at the world price, but with the tariff and the enforced use of alcohol the actual fuel cost is RM. 7 ($2.80 U. S.). Here is a wide margin for possible cost reduction that would allow of expansion of the automotive industry, which is among the greatest of our potential creators of work, industrial activity and prosperity.

It is characteristic of the world petroleum industry that while the statistics may show the countries of origin of imported oil, they give no clew as to the firms or groups that are the actual purveyors. As everybody knows, several large groups are active in practically all the producing countries of the world and a number of these groups by no means limit their operations to the countries in which they are domiciled. This inclusive character of several large oil companies has inspired erroneous ideas concerning the price-controlling power of these companies, which are popularly referred to as international oil trusts. Such ideas generally ignore the fact that the three greatest oil-producing concerns—the Russian oil trust, the Standard of New Jersey group and the Royal Dutch Shell group—control respectively only 11, 14 and 11 percent of the total world production (according to 1934 figures). These great groups are not only competitors among themselves but they also have to contend with numerous other producers who are in a position to exploit price differentials in any part of the world. This competition is all to the good of the consumer to the extent that he receives the benefits flowing from continued improvement in methods of production and distribution.

The great capital investments that nowadays have to be put into the production, refining and transport of petroleum products make it absolutely necessary to effect a thoroughgoing organization of distribution. This explains why by far the larger part of imported oil is retailed by the same firms that import it; oil importer and oil retailer in Germany are identical. The importance of this circumstance is often misunderstood. By his investments for storage, transport and distribution, the oil importer is closely bound up with the general structure of German economics. A concern that has to maintain and amortize large investments in Germany cannot withdraw from the German market today and come back tomorrow, according to fluctuations in prices; it must take the good or the bad as it comes. This is the reason why the mineral oil importers have always done their best to stimulate German business. Exports from German refineries go almost exclusively to companies outside the country that are intimately connected in a business way with the German owners of these refineries and a fair share of the orders of these great groups is placed with German firms. In all probability this good will would evaporate at once if the activity of the mineral

oil importers were cut off at the German frontier.

Imported oil not only binds the interest of a large international group to the interests of German internal business, but also bears a large share in smoothing the way for German exports. When Germany buys imported oil for RM. 100,000,000 or RM. 150,000,000 ($40,000,000–$60,000,000 U. S.) there is also created an export possibility of the same dimension. It is Russian oil that enables Germany to maintain its exchanges with Russia, and in the same sense this is true as a result of agreements with Holland, Roumania, etc.

There is one point on which Germany should bestow especial attention. The number of important countries that supply the world oil trade and consequently the oil trade of Germany is limited, and with the exception of the United States and Venezuela the volume of their oil exports is such that it appears desirable not to depend so much for Germany's oil supply on certain countries as is now the case. Again excepting Venezuela and the United States, if an order for several hundred thousand tons should suddenly be received in most of these countries under present conditions of international trade and exchange difficulties, prices would rise to an exorbitant extent. That this fear is not based wholly on theory is shown by the results of the artificial conditions that have been created in the German market for Roumanian oil. This result has been that gasoline and gas oil that could be bought at the world price for RM. 74,500,000 ($29,800,000 U. S.) when bought from Roumania costs RM. 98,500,000 ($39,400,000 U. S.). This RM. 24,000,000 ($9,200,000 U. S.) difference shows how important it is to keep open all possible sources of supply, both as regards geography and quality. This super-price for Roumanian oil is an example of the absurd economic situations that have been created by bungling politico-economic policies.

Underwood & Underwood

Charles Fahy

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Washington Foresees Renewal of Oil Battle

WASHINGTON, SEPT. 30.

WITH Congress adjourned and many administration officials absent from Washington the question of oil legislation has passed from the acute stage which it occupied for several months preceding adjournment. But it is just another case of a "breathing spell". The lines are being reformed; plans are being laid both by the advocates and the opponents of federal control, and the battle will be renewed with the opening of the next session.

Dr. George Stocking

Harris & Ewing

In this environment the activities most in evidence naturally are those of the supporters of a "strong" federal policy. The more ardent of these have not abandoned hope of establishing in oil a regulatory regime similar to that which the Guffey-Snyder act provides for coal. They are willing to remain quiescent for the present believing that events will play into their hands. They assume the position that a chance must be given to see what the interstate compact will accomplish. Privately they hold that it will be entirely barren of results in preventing overproduction and that this will become manifest by the end of the year. They are watching with special interest the situation in California where uncontrolled production has led to a cut in crude prices and are prepared to make the most of the breakdown in voluntary regulation in that state, particularly if waves of cheap gasoline flow into other markets and affect prices there.

When Congress reassembles it will still have before it the Cole bill with its provision for an independent petroleum board which remains on the House calendar unaffected by the authorization of an interstate compact which was accomplished by a joint resolution. Chairman Cole of the House sub-committee on oil undoubtedly will renew his efforts to secure the passage of this bill. Indications are that this will be one of the mildest proposals to be put before Congress. Several members are known to have bills in preparation, some of them incorporating the quotas in commerce feature combined with special taxation in the effort to make them constitutional. Most of these proposals probably will be confined to the production and refining phases of the industry and omitting marketing except as may be provided through clauses permitting industrial agreements by zones and areas.

In the meantime the marketing code worked out by the Arnott committee is expected to be received here sometime during October or November and the Federal Trade Commission is waiting for it. Its ultimate fate is, of course, uncertain.

Resignations of Chairman Charles Fahy

of the Petroleum Administration Board and Chairman George W. Stocking of the Petroleum Labor Policy Board are regarded as a first step in the dismantling of the special federal agencies dealing with oil. Stocking returns to his professional duties at the University of Texas from which he has had leave of absence since midsummer 1933. Fahy becomes general counsel to the new National Labor Relations Board administering the Wagner act.

Continuation by the Bureau of Mines of its monthly crude estimates which it publishes for the information of the various producing states is expected to help those desirous of preventing overproduction.

DON KIRKLEY

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Francis W. Rickett

WHEN the Associated Press correspondent in Addis Ababa filed a midnight dispatch on August 30 announcing that Francis W. Rickett had obtained from the Emperor of Ethiopia a concession for the development of oil resources in his kingdom he set off a news explosion that echoed around the world and made Mr. Rickett a figure of international note. For three days the affair was the subject of anxious conferences in the chancelleries of half a dozen nations as well as occasion of emblazoned headlines in the newspapers. Mystery as to the identity of the interests behind the African Exploration and Development Corporation to which the concession had been granted added to the popular interest in this matter.

The sensation ended when George S. Walden and H. Dundas, chairman and vice-president respectively of Standard Vacuum Oil Company, walked into the offices of the Secretary of State of the United States in Washington, announced that the concession had been obtained for their company as the result of negotiations begun long before war clouds gathered over Ethiopia and stated that they were willing to relinquish it if it appeared likely to cause embarrassment to the government. After a conference with Secretary Hull it was announced that the company had declined the concession.

While this action disposed of the matter as an international incident the interest in Mr. Rickett has persisted. Possessing a rather meagre array of facts regarding his career the newspaper writers have drawn heavily upon their imaginations, describing him as "the Lawrence of Ethiopia," "the mystery man of finance," and with other interest-intriguing appellations.

Among oil men Mr. Rickett is best known for his having obtained from the government of Iraq a concession for oil rights in that kingdom which was the basis for formation of British Oil Development Ltd. The successor to that corporation is Mosul Oilfields Ltd., in which AGIP, Italy's government backed oil company, now holds a major interest. Prior to the Iraq incident, however, Mr. Rickett had familiarized himself with many important oilfields, including those of Russia, and had visited many remote parts of the world in the quest for possibilities of petroleum development.

Francis W. Rickett

The accompanying portrait of Mr. Rickett, made especially for WORLD PETROLEUM in 1932, shows him as a very amiable and personable individual. There is nothing of the mystery man about him except that many of his activities in relation to oil have been such as naturally would not benefit by premature publicity.

Edward L. Doheny

WHILE oil discoveries have made many fortunes it is doubtful if the annals of the industry record any career more spectacular than that of Edward L. Doheny who died at Los Angeles, California, on Sept. 7. Born at Fond du Lac, Wisconsin, August 10, 1856, he gained a high school education and afterward, while still in his teens, joined a party of government engineers engaged in surveying public lands in the southwest. It was this experience undoubtedly that gave him the lure for prospecting that carried him all over the west during the next twenty years but it was gold, silver and copper rather than oil that was the object of his earlier quests.

It was not until the early nineties when Doheny reached California that he became interested in oil. He was one of the pioneers of the Los Angeles field and brought in his first well there in November 1892. Thereafter he became an active operator in that field bringing in altogether 81 wells with an aggregate production of 350,000 bbl.

This was before the day of the automobile and the demand for California crude was a limited one. In the effort to find new outlets Doheny turned his attention to the use of oil as a fuel for railway locomotives and spent much time in convincing railway officials of its advantages over coal under conditions prevailing in the southwest. This was not an easy task because the railway men had to be shown, before converting their equipment, first that oil was a satisfactory fuel and, second, that the supply was adequate to meet future needs. By persistent efforts Mr. Doheny satisfied the railway managers on both these points and he is credited with being largely responsible for the development of an early market for fuel oil among railways and industrial establishments.

The acquaintanceship formed among railway men was of immense value to Mr. Doheny because it caused him to take an interest in the development of new fields in California and led him eventually to Mexico, the scene of his greatest industrial triumphs. Through Gen. Strong, president of the Santa Fe railway, Doheny undertook to develop lands adjacent to the company's lines in California. It was through this connection that the Fullerton field was uncovered. Later he became active in the Kern River field. The holdings of Doheny and his associates in both these fields were sold subsequently to the Santa Fe and in 1900, following the suggestion of Gen. Strong, he turned his attention to Mexico.

The story of Doheny's Mexican experi-

ence, of Casiano No. 7 with its production of 75,000,000 bbl. in ten years, of Casiano No. 4, the world's greatest gusher with a flow of 260,000 bbl. per day, of the Cerro Azul field and other remarkable properties of Doheny's Mexican Petroleum Company, is a familiar one to oil men. All past production records paled to insignificance compared to those established along the Gold Coast of Mexico between 1910 and 1920.

During this period Mr. Doheny did not abandon his interest in California. He was identified with the development of a number of California fields and organized the American Petroleum Company, American Oil Fields Company, Midway Oil Company, California Petroleum Company and Pan American Western Company, some of these being mergers of existing companies.

It was Mr. Doheny's interest in providing an adequate supply of oil for the use of the United States Navy that led to the unfortunate events that clouded the later years of his life. It has always been contended by his friends that the project for the Elk Hills lease and for the building of great storage facilities at Pearl Harbor in Hawaii did not originate with Mr. Doheny but was urged upon him by government officials and that he entered upon it from patriotic motives. Certainly he had passed the point where the mere acquisition of money had power to attract him. It is possible to demonstrate, moreover, that the government lost rather than profited by cancelling the Elk Hills lease. The episode of Doheny's loan to Secretary of the Interior Fall who had authority to grant the lease brought great opprobrium on both but Mr. Doheny staunchly adhered to the explanation that it was a mere act of assistance to an old friend and those who knew Doheny believe this to be the truth, whatever may have been the motive of the Secretary in soliciting the loan. To those who knew Mr. Doheny it was impossible to picture him as deliberately setting out to bribe a public official and they feel that justice did not suffer by his acquittal on this charge.

Edward Laurence Doheny

Since the death of his son in 1929 Mr. Doheny had gradually withdrawn from business activities and his last few years were spent in practical seclusion in his Los Angeles home.

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Changing Source of British Crude Supplies

EXAMINATION of the details of British petroleum imports for the six months ended June 30, 1935, suggests important changes in the sources of supply. Total crude and all products imported, was 41,268,028 bbl., and set a new high record for the first half of any year, rising 2,926,686 bbl. or 7.6 percent on the aggregate for the corresponding period of 1934.

This increase, nevertheless, was due entirely to larger arrivals of motor spirit, fuel oil and crude, the three largest categories in the import list, all other classes of oil products registering a decline. Experience in the British oil import trade has thus differed widely from the January–June period last year, when inward shipments of crude and each individual product showed an advance on the corresponding figures for 1933.

Larger imports of motor spirit and fuel oil may be said to reflect, directly or indirectly, the rising volume of British industrial activity, but with this consideration in view, it is at first sight difficult to account for the relapse of 11.7 percent in lamp oil and of 19.1 percent in gas oil receipts. There are nevertheless explanations for the declines. Kerosene imports, for example, compare with a relatively high import total during the first half of 1934, and the same applies to the various specialized products imported under the heading of "Other sorts." In addition to the factor already mentioned, kerosene imports were severely restricted during the early months of 1935 by exceptionally mild weather, which, coming at the end of the normal winter demand, led to a general disinclination among distributors and users to replenish stocks. This tendency was accentuated to some extent by the temporary diversion of supplies normally reaching Great Britain from the United States. The weather factor also affected imports of gas oil, which is imported principally for use in enriching coal gas.

In explanation of the set-back of 5.9 percent in lubricating oil shipments, it should be recalled that considerable extensions have been made within recent years in plants designed for lubricating oil production in Britain.

Detailed statistics showing the sources of supplies during the six months suggest a major alteration in the trend of British importing policy. Imports of crude oil from Iran, which have been declining on balance for some years, show the remarkable falling off during the first six months of 1935 of 2,385,256 bbl., equivalent to no less than 64.7 percent of the aggregate for January–June 1934. This heavy contraction in Iranian crude shipments has been almost exactly made good by an increase from the negligible amount of 174,000 bbl. to 2,377,743 bbl. in imports from "Other Countries." Although British oil imports from Iraq are not yet classified separately in the official returns, it is known that the advance under the heading "Other Countries" is due entirely to the shipment of Iraqi crude, following the opening of the Iraq Oil Company's pipeline. So abrupt is this change from Iranian to Iraqi crude supplies in Britain that it can hardly have occurred otherwise than by an arrangement between the various interests concerned in taking supplies from the two countries. Such an arrangement would be a perfectly logical move in view of the fact that the Anglo-Iranian Oil Company, which has the monopoly of Iranian shipments, holds a 23¾ percent interest in the Iraq Petroleum Company, and participates in a marketing alliance in Britain with the Royal Dutch-Shell Group, which also holds 23¾ percent of I.P.C. capital.

Other sources of British crude imports show little change as compared with the corresponding period of 1934, although Peru, from which country Lobitos draws supplies for its refinery, shipped the slightly increased total of 1,246,286 bbl. to British ports.

Foreign Oil Legion

PROFESSOR VLADIMIR N. IPATIEFF, associate director of chemical research for the Universal Oil Products Company in Chicago, is undoubtedly one of the most colorful figures in the international oil industry of today. Professor Ipatieff began research work in catalytic reactions under high pressures with organic matters as early as 1900 working in the laboratories of the Academy of Artillery in St. Petersburg. He is a pioneer in studies of chemical reactions under high pressures both with organic and inorganic matters. His first important discoveries were made in 1902 when he discovered catalytic dehydrogenation of alcohols obtaining from such reactions aldehydes and ketones and simultaneously discovering a method of making olefines (unsaturated hydrocarbons), the discovery of the later reaction being very important industrially. Then in 1903–1904 he experimented extensively with the use of high pressures in hydrogenation of various organic combinations, these experiments being the forerunner of the Bergius process. In 1905 Professor Ipatieff first introduced high pressures in polymerization of ethylene and other olefines. Continuing studies of polymerization in the presence of various catalytical agents Professor Ipatieff found an agent which allows at this time the transformation of a portion of the gases from the cracking operations, containing olefines, into an excellent high octane gasoline. The work of Professor Ipatieff in catalysis during the last thirty-five years enriched the science by several major discoveries: he discovered several new catalytical agents such as iron, zinc, manganese and their dioxides (first introduced by Professor Ipatieff in practice) and, also, he first indicated the action of promoters on the accelerated activity of catalytic agents. In the last few years several other important discoveries were made by Professor Ipatieff. For his work Professor Ipatieff is internationally recognized. He is a member of the Russian Academy of Sciences; member of the Academy of Science of Gottingen; honorary Doctor of Munchen University; Doctor of Chemistry of Leningrad University; honorary Doctor of Strasbourg University; honorary member of Deutche Chemishe Gesellschaft. Professor Ipatieff is a Commander of the Cross of the Legion of Honor. He was the recipient of the Berthelot Medal of the French Academy of Sciences; of small and large decorations of A. I. Boutlerov of the Russian Physical-Chemical Society and the large decoration of Ivanoff of the Russian Academy of Sciences. Professor Ipatieff is a graduate of The Academy of Artillery and during the great war, with a rank of general, was in charge of all chemical work of Russian government. After the revolution Professor Ipatieff became President of the Central Chemical Bureau in Moscow and was the founder of the High Pressure Research Institute, for this work he was the recipient of the Lenin prize.

Dr. Vladimir Ipatieff.

Blank & Stoller

Captain J. W. Flanagan.

CAPTAIN J. W. FLANAGAN, president, Andean National Corporation, visited New York from his Toronto headquarters during the latter part of September. Captain Flanagan directed the construction of the Trans-Andean pipeline, an undertaking which was generally considered impossible, prior to completion.

H. F. ABRAMS of Socony-Vacuum Corporation is on a trip to France, Italy and Germany where his company is engaged in extensive construction activities under his direction.

ELECTION of James H. Lewis as president of the newly-organized Sunset Oil Company by directors of the company, was announced during September. Mr. Lewis' headquarters will be in Los Angeles.

James H. Lewis.

World Petroleum Abstracts

Summaries of the Most Important Articles as Published in the Oil Press of the World Dealing With Technical and Economic Aspects of the Industry.

Dr. O. W. Wilcox

Petroleum Geology

COMPRESSIBILITY OF SAND.—H. G. Botset and D. W. Reed, in BULL. AM. ASSOC. PETROL. GEOLOGISTS, vol. 19 (1935), No. 7, pp. 1053–1060.

An experiment is described in which the compressibility of a 30–40-mesh sand was measured at pressures up to 3,000 pounds per square inch. There was only a 2 percent change in pore volume between no load and full load. Since the sand used in the experiment was unconsolidated, the compressibility of even a slightly consolidated sand should be much less, and it is apparent that compressibility of a sand is, in general, a minor factor in oil production.

CARBON RATIOS IN PARTS OF ARKANSAS-OKLAHOMA COAL FIELD.—Thomas A. Hendricks, in BULL. AM. ASSOC. PETROL. GEOLOGISTS, vol. 19 (1935), No. 7, pp. 937–947.

An isocarb map of a part of the Arkansas-Oklahoma coal field and the data on which it is based are given. The variations in fixed-carbon content in the coal from bed to bed and from place to place are pointed out and discussed. The writer concludes that: (1) differences in original composition have had little effect on the fixed-carbon content of these coals; (2) differences in amount of overburden have produced no increase in carbonization from a younger to an older coal bed in this area; and (3) the major variations in fixed-carbon content of the coals of this area are directly related to structural deformation by pressure from the south.

TECHNICAL BASIS OF BLEACHING CLAY INDUSTRY.—P. G. Nutting, in BULL. AM. ASSOC. PETROL. GEOLOGISTS, vol. 19 (1935), No. 7, pp. 1043–1052.

The bleaching clays of commercial interest are the active clays of the Southeast and the activable bentonites of the Southwest and Southeast. No first-class clays of either type have yet been found in the Mid-Continent region. All the best active clays are substantially equal in bleaching power. The same is true of the activable clays. Each individual differs less from others in the same class than the variation with depth in one deposit. Practically unlimited quantities of the highest grade clays of both types are available and there are vast reserves of each only slightly inferior. Although other clays and minerals nearly as high in bleaching power as the active and activable clays of commercial interest have been found, none exceeds them in bleaching power or can compete with them in price. Glauconite and Ordovician bentonite, properly prepared, may be of special service locally; they can not compete with the commercial clays for bleaching purposes at present. Special treatments of clays enhancing their bleaching power have been found to be not worth the added cost. Methods of testing and rating bleaching clays are briefly outlined.

MICROFAUNA OF LOWER CRETACEOUS HORIZONS IN NORTH GERMANY.—W. Eichenberg, in PETROLEUM, vol. 11 (1935), No. 23, pp. 388–412.

This work lists and figures 320 species of microfauna obtained from core samples taken from drill holes penetrating lower cretaceous formations in North Germany. Sixteen distinct zones are represented and characterized for correlation purposes.

Drilling

SPEED AND WEIGHT AS FACTORS IN OIL WELL DRILLING.—B. Mills, in OIL WEEKLY, vol. 78 (1935), No. 6, pp. 25–28.

It has long been known or suspected that there is a relation between the weight and speed of drilling tools on the one hand and footage of hole drilled per day on the other. The matter is now being made the subject of more intensive study by the major oil companies in California and the Gulf Coast and the results have been enlightening. In general, experience has shown that light weight on the bit and rapid rotation of the drill is the best rule, but many formations offer exceptions. In soft formations of the Gulf Coast a load of three points on the bit and 150 r.p.m. have allowed of making 1,000 feet of hole a day; in such cases it is actually the slush pump that breaks the formation ahead of the bit. Too much weight in soft formations causes the bit to ball up unless the pump pressure and mud volume are also proportionally regulated. In edge wells drilled with light weight and high speeds there is a pronounced tendency for the hole to drift down-structure, but this has been successfully counteracted by increasing the weight and reducing the speed. The Texas Co. has found light weight on the bit and rapid rotation very effective, in drilling through sticky gumbo; however, the critical weight in drilling Gulf Coast gumbo is low; excess weight gives a grinding and mashing action that leads to an accumulation of cuttings near the bottom of the hole unless the pump is operated at a corresponding rate. On the other hand heavy use of the pump often loosens slugs of sticky formation and adds friction near the bottom of the hole. In some cases speed and weight are of much importance in the drilling of straight or crooked holes. In one field, operators had been unable to drill a straight hole with two to three points of weight and a rotary speed of 125 r.p.m.; the weight was doubled and an almost straight hole resulted. Added weight is one of the principal means of successful drilling through slanting formations. The general conclusion is that there is a critical weight speed of rotation for all formations, and this must be learned.

WELDED CASING PRACTICE.—B. Mills, in OIL WEEKLY, vol. 78 (1935), No. 8, pp. 19–28.

The welding of casing as it goes into a well is not new practice, but it has heretofore been applied only to larger casing strings. The present instance relates to its application by the Sinclair Prairie Oil Co. to a 6¼ inch pipe for which it was necessary to develop a technique for rapid and economical welding operation. A special jig or guide for holding the pipe in place and aligning the two joints being welded was devised for speedy work. A very fast welding rod is used, and a complete weld is made in two minutes. The welded strings have varied in length from 2,500 to 3,800 feet. The advantage of the method is that new casing can be manufactured at a lower cost when couplings and threading are not included. On the other hand, welding at the hole requires about double the time to run the casing, so that to this extent the time element favors screw casing. In this particular instance, the casing used was pipe that had been salvaged from a discontinued pipe line.

COMPRESSED AIR FOR DRILLING POWER.—B. Mills, in OIL WEEKLY, vol. 77 (1935), No. 12, pp. 29–30.

The existence of a large battery of idle gas compressors prompted the Barnsdall Oil Co., Elwood field, Calif., to experiment with compressed air as a source of drilling power. The air is compressed to 175 lbs., passed through a heater to raise the temperature to about 200° F, and then enters the drilling engines and mud pumps in the same manner as steam. The operation is satisfactory, although no cost studies have been made.

DRILLING IMPROVEMENTS IN 1934.—Warren L. Baker, in OIL WEEKLY, vol. 77 (1935), No. 12, pp. 21–23.

Among innovations in drilling practice noted in this review was the introduction of directional drilling, which has been put to some spectacular uses, such as extinguishing a burning well. A California company has satisfactorily introduced compressed air for drilling a well in the Pacific Ocean. The completion of three producing wells under one

derrick demonstrated the value of multiple drilling where foundations are a problem. This same problem so far as it relates to marine drilling has also been solved by the use of submerged barges. While these are the outstanding novelties, it is still a fact that all appliances used on the drilling rig and in completing the well have been improved. New types of mud equipment have appeared, and chemical treatment of muds has improved. Improved methods of testing oil sands was another feature of the year. A spectacular advance was the use of gun perforators for penetrating blank pipe and producing formations. Pressure drilling has come into more favorable use. One of the most significant trends is deeper penetration. A bibliography of these achievements is given.

Electrical Logging.—J. C. Karcher, in OIL WEEKLY, vol. 78 (1935), No. 5, pp. 86–91.

This paper deals with the construction and use of an attachment to the drill bit of a rotary rig, whereby a continuous record is automatically obtained of the resistances of the formation as drilling proceeds. The principal advantage of this method is that the character of the profile is disclosed step by step without coring; oil or gas sands may be recognized as soon as they have been penetrated a short distance. Of particular notice in the logs of wells drilled with this device is the accurate information available for correlation. In areas of erratic sand lensing it is difficult to correlate the sands unless the wells are closely spaced, but this obstacle is overcome to a great degree by electrical logging, since the correlation may be made on certain datum points rather than on sands.

Diesel Electric Power for Drilling.—W. C. Lane, in PETR. ENG., vol. 6 (1935), No. 11, pp. 33–35.

An innovation in the drilling of a wildcat well is represented by the installation of Diesel electric power at a well of the Gypsy Oil Co. in Oklahoma. The power plant includes two 175-kw., 200-volt, 1200 r.p.m. differentially wound separately excited d-c Westinghouse generators and an exciter. The motors are used to operate the draw works, slush pumps. About 10 bbl. of fuel oil is used daily. At present writing the well is down 4,100 feet and the rig is operating with high efficiency.

Behavior of Cement Grouts under Oil Well Conditions.—S. L. Meyers in PETR. ENG., vol. 6 (1935), No. 11, pp. 51–54.

In cementing an oil well it is still largely a matter of conjecture as to in what condition the cement will be a day or a week after the cementing job has been finished; and if failure occurs the cause will remain in doubt. This uncertainty is largely due to the fact that comparatively little has been done (or at least published) on the determination of the properties of neat cement pastes containing sufficient water to make a pumpable fluid, or as regards the effect of different well conditions on the behavior of this fluid. The present paper is an attempt to state the conditions under which cements for oil well work should be tested. Such tests are: determination of effect of mixing water on strength; temperature effects on fluidity; effect of cement fineness; and effects of pressure on neat grouts. Excess water weakens the tensile and compressive strengths. Temperature affects the workability or consistency of the paste; a cement that pumps easily with 40% water at 70° F. becomes stiff and difficult to work at 180° F., and more water must be added to increase the fluidity. This is of importance where high bottom-hole temperatures are encountered because not only is the setting time hastened but the grout moves with difficulty; multiple-stage cementing and temperature-resisting cements will minimize the difficulty. The finer the cement is ground the more water has to be mixed with it to reach a certain consistency, and setting time and hardening rates are accelerated. Where quick-setting occurs, due to high well temperatures, it appears logical to use a coarse-ground, slow-setting cement. Tests show that strength and permeability are not harmed by coarseness if the temperature is high enough. Studies on the effect of pressure show that pressure only accelerates setting time to a small extent, irrespective of percentage of water used, and it is believed that the high pressures prevalent in deep wells do not contribute to cement failure at all by affecting strength setting times or permeability.

Natural Gas

Production of Gasoline by Polymerization.—C. R. Wagner, in IND. ENG. CHEM., vol. 27 (1935), No. 8, pp. 933–936.

Gases from low-pressure vapor-phase cracking containing 20 to 24 per cent of ethylene, 13 to 18 per cent of propylene, and 6 to 10 per cent of unsaturates in the four-carbon group were polymerized to liquid products by heat and pressure in the absence of catalysts.

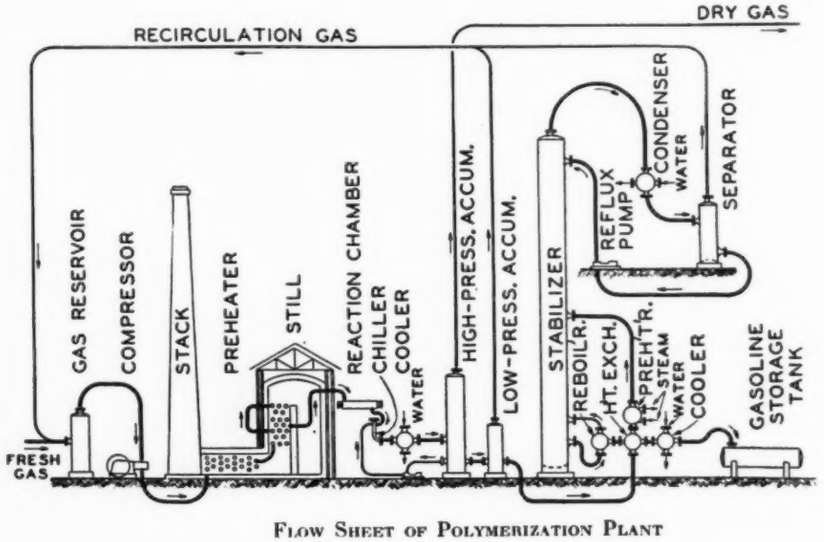
On a once-through basis 1.7 gallons of gasoline per thousand cubic feet were obtained operating at 950° F. and 800 pounds pressure; the yield was increased to 3.0 gallons by recirculating the gas derived from stabilizing the liquid products. The yields were improved in a commercial unit to 3.25 gallons. By processing gas from stabilizing vapor-phase cracked distillates, 9.0 gallons were obtained. By operating at low pressure and 1200° to 1300° F., the liquid products were mostly aromatic. A flow diagram of the process used is shown in the accompanying figure.

Reid Vapor Pressure Test on the Pacific Coast.—R. P. Crippen, in OIL AND GAS JOUR., vol. 23, No. 50, pp. 57; 60; 64.

In reviewing the general situation with regard to the development of the Reid test on the Pacific Coast, it is evident that, while there is considerable room for improvement through modification of test procedure, the industry is not faced with adverse situations resulting from confusion in the application of the various alternative provisions of the existing method to current operating problems. While it would be desirable to reduce the method to one set of universally applicable conditions, apparent difficulties exist, due to the widely variant nature of the materials to which the test is applied on the Pacific Coast. In as much as there appears to be little trouble generally in obtaining duplicate and consistent results with the existing method, any moves toward its revision should be made slowly and carefully, to avoid the damaging effects of possible confusion resulting from poorly considered changes.

The Problem of Noncondensible Gas.—R. Fussteig in CHIM. ET IND., vol. 34 (1935), No. 1, pp. 3–9.

A regrettable concomitant of petroleum production in oil fields remote from industrial districts or large centers of population, as in Poland and certain parts of the United States, is the wastage of immense volumes of hydrocarbon gases from which all liquefiable components have been removed. The author has been devoting considerable experimental work



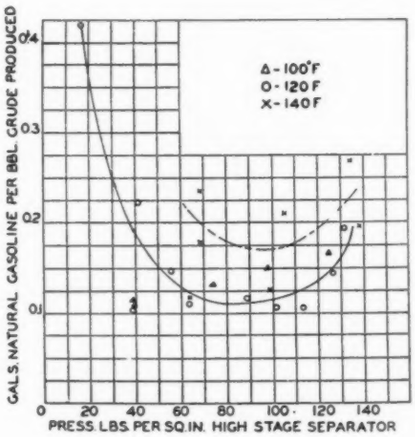
Flow Sheet of Polymerization Plant

to an effort to find what to do with dry gas. So far, the most promising solution of the problem has been the catalytic decomposition of this gas at 750° to 940° C., using molybdenum, nickel and cobalt catalysts. The result is production of a large proportion of olefines along with various quantities of aromatic hydrocarbons and free hydrogen. These olefines may be converted into cholorine derivatives from which aldehydes, alcohols and a whole series of chemical products can be prepared.

This is good so far as it goes, but at present the consumption of such chemical products is not yet on a scale sufficient to provide for a large tonnage, and certainly not for absorbing the whole of the available raw material. What the gas producers in the remoter districts would welcome is another catalytic process, whereby the hydrogen and the olefines formed in the first process might be recombined into condensible products. This is a large field still awaiting some resourceful inventor.

Stage Separation of Crude Oil and Gas Mixtures.—R. L. Huntington, W. F. Cloud and W. F. Matheny, in OIL WEEKLY, vol. 78 (1935), No. 7, pp. 31–34.

In a previous paper the authors showed that the optimum ratio of pressure between high-stage and low-stage separators should be around four or five to one. It was further pointed out that with adoption of stage separation it is possible to bring the gas into the plant with smaller lines and to postpone purchase of compressor equipment until back pressure in the separators falls below that required for efficient absorber work.



With stage separation the gasoline plant is assured that less crude oil mist will escape from the high pressure separators than from the low pressure tanks which usually receive the oil-gas mixture direct from the well. The results of the present research also show that there is an optimum ratio of separator pressures for obtaining a low gas-oil ratio, depending on the temperature. The accompanying figure shows that by taking the product of the gasoline content and the gas-oil ratio, the number of gals. of gasoline per bbl. of crude oil is obtained. Low-stage=14.2 lbs. sq. in. absolute.

Intermediate Cooling of Absorption Oil.—George Weber, in OIL AND GAS JOUR., vol. 33 (1935), No. 50, pp. 50; 54.

In the operation of the Hanlon Gasoline Corporation plant in East Texas a method of absorption oil cooling is employed which reduced the required oil-gas ratio to half the usual figure.

At two points along the tower the oil is blanked off, run through exterior coolers and returned to trays slightly below the respective blanked ones. At each cooler, temperature drop of 10° is attained. The lean oil enters the top of the absorber at approximately 80° and leaves as rich oil at 105° F. Actually the temperature rise throughout the process is 45° F., but the intermediate cooling of the oil results in a superficial rise of only 25° with the attendent increase in absorptive capacity.

Interstate Pipe Line Systems in the United States, Anon., NAT. GAS, vol. 16 (1935), No. 5, pp. 28–69.

A set of maps is given showing the routes and territories served by 24 principal natural gas pipe line systems in the United States. Accompanying the tables are data showing locations of the important gas fields, miles of pipe lines, number of compressing stations and the horse power of these stations, number of communities served and the population of these communities, and the total number of consumers. The number of consumers served in 1934 is given as 7,166,000, representing a population of 33,050,000. These pipe line systems transport natural gas from 17 states.

Oil Well Operation

Production Problems in Jacob Pool.—George R. Pinkley and Earl S. Post in OIL WEEKLY, vol. 77 (1935), No. 11, pp. 27–28.

A combination of low pressure, sand and shale in the shallow Jacob field of South Texas gave rise to a variety of production problems which required some experimentation to settle. One device worth special mention is washing-in with oil. A well with 42-bbl. initial flow was washed 48 hrs. by circulating oil, with the result that flow was increased to 250 bbl. and after 2½ years is still producing 80 bbl. The oil washing is credited with a large portion of this recovery.

Contamination of Cores.—Wm. L. Horner, in OIL WEEKLY, vol. 78 (1935), No. 3 pp. 29–30; 71.

Modern repressuring and water flooding operations require that much reliance be placed on the results of tests on cores. These tests are supposed to show the amount of oil, gas and water left in the sand, but if the oil and gas have been displaced by water from the drilling fluid, the conclusions to be drawn become uncertain and possibly misleading. The author has undertaken a research to determine what portion of the water found in a core could have come from the drilling fluid. The principle of the method is to add a certain chemical to the drilling fluid, and examine the core to see how much of this chemical has been absorbed. Much, of course, depends on the choice of chemical; it should be one that is soluble in water, is not selectively absorbed by the formation, it should not react with any other material contained in the drilling fluid, and it should be cheap enough to admit of frequent use. Normal or isopropyl alcohol has seemed to be the best chemical for the purpose. When the core is removed from the hole the water in it is expelled by retorting in the usual way and the amount of the alcohol in this water is determined. For example, if analysis of water contained five percent alcohol and the drilling fluid 50 percent, then 10 percent of the core water was contamination from the drilling fluid.

Sand Selectivity Completion.—Earl S. Post, in OIL WEEKLY, vol. 77 (1935), No. 12, p. 80.

The method of sand selectivity completion of an oil well is defined as the practice of drilling a hole to the contract depth, setting a string of casing to bottom and then selectively testing all prospective horizons by perforating the casing.

In this method of completing, which is particularly popular on wildcat tests, the wells are cored and tested regularly in the usual fashion when being drilled. After reaching the contract depth, however, an electric logging or formation testing device is run. These tools indicate the most favorable oil-bearing sections of the hole. Casing is set and cemented and each sand is tested individually. The perforations are made in the casing opposite the bottom sand, then, if it is not productive, the hole is plugged back to the next sand and the process repeated. A number of interest strikes have resulted from this method of testing.

A practice by some is to shoot into chalks and limes, in order to make deep channels through which to acidize. This has proved unusually successful in some districts.

Cement for Oil Wells.—D. E. Silcox and R. B. Rule, in OIL WEEKLY, vol. 78 (1935), No. 7, pp. 21–26.

The authors emphasize the fact that ordinary specifications for cement for building purposes do not cover the particular requirements of cement for oil well purposes. What the oil man requires is a cement that takes the least amount of water to make a pumpable slurry, and one which will set to a mass with low porosity and low permeability. It is now specified that tests on oil well cements be made on a 40 percent slurry. It is predicted that future progress will lead to slurries with lower water content, but at the present time there are still cements on the market that require as much as 60 percent. Also the cement must be free from particles likely to cause trouble with the pump valve; hence it is specified that 100 percent of the cement must pass a standard 30-mesh screen. There remains the "oil-well cement mixing test," for which the engineering department of the Standard Oil Co. of Calif. has devised a special apparatus consisting of a two-quart mixing chamber furnished with revolving and stationary paddles. The revolving paddles are driven at constant speed by a motor, and there is an arrangement for measuring the torque required for mixing the slurry. The outfit has much the appearance of an ice cream freezer. The paddles revolve

at 60 r.p.m. for 20 minutes and 14.5 r.p.m. for the balance of the time, which is 2 hrs. 20 min. It is specified that the slurry must remain fluid during this entire time; the slurry is considered to have a good consistence if the pull on the torque-meter does not exceed eight ounces 30 minutes after the start. Most acceptable cements have a "consistency" of three to six ounces. An apparatus of the kind described is being furnished by the oil company to the cement manufacturers who supply it with cement.

Next follows the strength test, for which it is specified that the tensile strength of briquettes cured for 1, 4 and 28 days at 70° F. shall be not less than 100, 250, and 350; the 28-day strength shall not be less than the 4-day strength. Cements meeting these requirements have been used in California wells from 3,000 to 6,000 feet deep, giving excellent service and a minimum of trouble. The mixing test, which is of most importance, can be varied to suit particular requirements.

Two Wells Five Feet Apart.—Anon., PETR. ENG., vol. 6 (1935), No. 10, p. 49.

For the sake of economy in both drilling and producing operations two wells in the Signal Hill field, Calif., were drilled five feet apart, each hole being completed in a different horizon. One is 4500 feet deep and the other 4950. After the first well was completed and on production, the rig was skidded five feet and the second hole was put down. The rig was then skidded back 2½ feet, and both wells are operated with one engine more smoothly and with less jerking than is usually the case when only one well is being pumped. There is also saving of power.

Stage Separation in Production of Crude Oil and Gas Mixtures.—R. L. Huntington et al. in OIL WEEKLY, vol. 78 (1935), No. 6, pp. 19–24.

Crude oil from the deeper oil wells usually contains a large proportion of gas dissolved in the oil; the efficient separation of these constituents is a matter of considerable practical concern to avoid loss of salable material, or, what amounts to the same thing, the production of a crude with good A.P.I. gravity. The tendency now is to effect separation by what is known as differential flash vaporization in which the dissolved gases are vaporized in successive stages by flash vaporization at different pressures. From this work done at the University of Oklahoma it is concluded that little is to be gained by effecting separation in more than two stages, and that the optimum ratio of pressures between the high and the low stages is about five to one; this is in approximate agreement with results reached by other investigators.

Sucker Rod Fatigue.—F. B. Bayless in OIL & GAS JOUR., vol. 34 (1935), No. 15, pp. 26–30.

Viewed casually, a sucker rod appears to be merely an elongated bar with upset threaded ends, but to the production engineer it is a vital piece of equipment which may be the source of much cost and other operating griefs, especially in oil wells where hydrogen sulphide and corrosive fluids are present. These circumstances call for much thought and care in the selection of sucker rods. As outlined by the author the successful rod for corrosive and sulphide service should have the following characteristics which are listed in the order of their importance.

1. Inherent resistance to corrosion and embrittlement.
2. Uniformity of composition and physical condition to eliminate localized zones of corrosive attack.
3. Sufficient fatigue resistance to allow the highest possible operating stresses.
4. Extreme toughness, ductility and resistance to stress concentration.
5. Cost which is commensurate with service rendered.

When what is required is known it is then in order to consider means for meeting the requirements. Various tests applied to the materials of which sucker rods are made (aside from the crucial field test) are outlined by the author and explained in detail.

Petroleum Refining

Solvent Refining.—M. J. Livingston and J. T. Dickinson, in NAT. PETROL. NEWS, vol. 27 (1935), No. 27, pp. 25–29.

The authors consider the relative merits and the properties of solvents in the refining of lubricating oils with especial reference to conditions confronting the oil refiners of Pennsylvania. The discussion relates principally to the use of the packed tower for solvent extraction, the characteristics of phenol as a solvent, and the special uses to which propane may be put for specific results. As regards phenol, the use of this solvent as recently applied, using water as an addition to the extract before removal of the latter from the system, leads to results above what may be obtained by the use of most other solvents.

Using phenol in this way, the effect of two solvents is really obtained, since the fresh anhydrous phenol last in contact with the raffinate controls the nature of the raffinate oil, while aqueous phenol in the extract controls the nature of the extract oil removed from the system. Anhydrous phenol, being an excellent solvent for naphthenic oil, prevents any low viscosity index oil coming out with the raffinate, while the aqueous phenol, being a poor solvent for paraffinic oil, prevents any serious loss of high V. I. oil to the extract.

Trapped between two such solvents, one at one end and one at the other, the oil charge is separated most completely into maximum yield of paraffin oil of the desired V. I. and extract oil of extremely low V. I. and low A. P. I. gravity.

Propane owes its versatility as a solvent to the fact that its properties change very markedly over the temperature range between minus 44 F., when its vapor pressure is equivalent to atmospheric pressure, and 212.2 F., its critical temperature. At minus 44 F. wax is essentially insoluble, but the oil remains in solution, while at 212.2 F. no viscous oil remains in solution. In the temperature range of 100 to 212 F., and under its vapor pressure, propane shows the surprising and novel property that instead of behaving like an ordinary liquid, and dissolving more of any partially soluble substance as the temperature is raised, it actually dissolves less.

Used with other solvents (cresols, phenols) propane is generally considered to assist in removing the high molecular weight and naphthenic compounds by reducing the solubility of these materials in the paraffinic oil. The ability to give high yields of excellent colored oil of low carbon residue and high V. I. from low quality residual stocks is the outstanding characteristic of this process.

Removal of Mercaptans from Naphtha by Caustic.—J. Happel and D. W. Robertson, in IND. ENG. CHEM., vol. 27 (1935), No. 8, pp. 941–943.

The presence of mercaptans in light petroleum distillates is undesirable because of their disagreeable odor and corrosive nature. Gasoline, solvents, and kerosene are acceptable when sweet according to the doctor test. In order to meet this condition, the mercaptan sulfur content of a distillate must not exceed about 0.001 weight per cent of mercaptan sulfur.

The use of caustic soda is an effective means of accomplishing reduction in the mercaptan content of naphthas. Because of their weakly acidic nature, mercaptans can be only partially removed by direct caustic washing, and such washing must usually be followed by a sweetening process to remove final traces. After a discussion of the chemistry of caustic scrubbing and giving data and methods of calculation in typical refinery applications, the authors conclude that the customary method of simply bubbling naphtha through caustic will be less efficient than mixing in a centrifugal pump.

Upward Trend of Gasoline Volatility.—G. G. Oberfell, R. C. Alden and H. M. Trimble in OIL AND GAS JOUR., vol. 34 (1935), No. 7, pp. 45–48.

This paper is intended to supply information that has been lacking since the Bureau of Mines discontinued its semi-annual surveys of the trend of volatility of motor fuels. The result of the present survey is to show that the volatility of Mid-continent motor fuels has increased appreciably in the period 1929–1934, the increase applying in almost the same degree in each of the three principal grades (house brand, premium and third grade). The greatest increase in volatility has occurred in the classifications of 50 and 90 percent evaporated (Engler distillation).

Preserving Cracking Equipment.—O. E. Andrus, in OIL & GAS JOUR., vol. 34 (1935), No. 11, p. 34.

In its first beginnings the oil cracking industry was highly hazardous because of corrosion, erosion, and explosion of the equipment; the development of the industry has principally been a fight against corrosion and a search for resistant materials of construction. The first attempts to counteract deterioration were in the way of increasing wall thicknesses, and the use of protective coatings, such as chromium plating and aluminium spraying. These last are good enough in their way, but are subject to mechanical injury and have not wholly met the need of the refiner for a dependable and economical vessel that completely resists corrosion. Recently metallurgists developed the use of carbon steel for load carrying purposes in conjunction with a

substantially permanent stainless alloy lining of appreciable thickness. It is applicable to any or all load-carrying sections of vessels, including the shell proper, heads, manways, nozzles, gasket seats, etc. One-inch spacing of the welds is preferable for oil cracking service because of the severe temperature conditions involved. This method of construction insures freedom from porosity, uniform composition throughout, and permanency of attachment even under rapid temperature changes.

Alloys of the high-chrome and chrome-nickel types are most suitable for lining material in oil service. The first sheet alloy lined cracking still was equipped with the latter type, and although this lining suffered intergranular corrosion, it is still giving complete protection for the load carrying steel. Alloys of this composition are now available, which are not subject to such attack. All installations so far made, including those that have given constant service for four and five years, have furnished 100 percent protection to every portion of the load carrying steel so covered.

CHOOSING A CORROSION-RESISTANT ALLOY.—T. Holland Nelson, in OIL AND GAS JOUR., vol. 34 (1935), No. 7, pp. 25–28.

Accumulated experience has shown that the so-called stainless steels or corrosion resistant alloys now available can be classified into four groups, to wit: straight chromium steels, straight nickel steels, chromium nickel steels and nickel-chromium steels. The author shows how, by taking an average piece of material from each of these four groups in the form of a short length of tube or other suitable fitting and subjecting them to a 30 day test under any particular corrosive condition, it is possible, by observing the results, to reach a dependable conclusion as to the composition of an alloy that will answer the requirements of the situation.

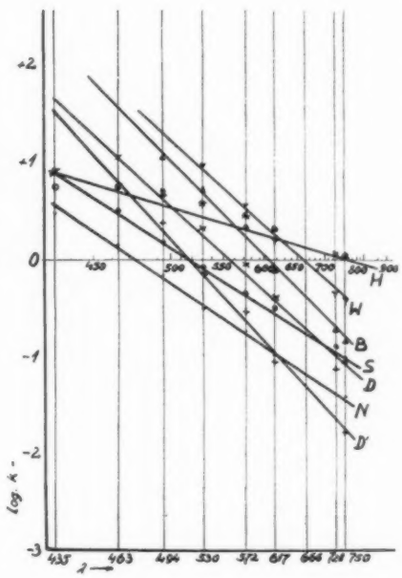
Petroleum Physics

THE BOUNDARY FRICTION OF OXIDIZED LUBRICATING OILS.—E. R. Redgrove, in JOUR. INST. PETROL. TECHNOLOGISTS, vol. 21 (1935), No. 141, pp. 612–633.

This interesting paper is a contribution toward an explanation as to what is the real reason why a lubricating oil lubricates, or in other words, on what does the "oiliness" of an oil depend? It now seems to be agreed that the lubricating value of an oil film is due to the existence of "polar" molecules in the oil; that is, molecules that have the property of attaching themselves to a metal surface in much the same way as a small magnet might attach itself by one of its poles to an iron bar. When such a layer is formed between the two faces of a bearing the attached molecules hold fast and keep the metal surfaces from touching. Differences in the lubricating values of oils will reside in the proportion of polar molecules contained in them, and also in the "polar" strengths of these molecules. The shape of the molecules is also of importance; long molecules, which attach themselves by one end exposing a relatively long free chain which can bend under the pressure of the bearing, are especially desirable in a lubricating oil. Still more desirable are "multipolar molecules," which can attach themselves to the metal not only by the end but also at several other points, thus forming a firmly adhering mat or film. Fatty acids may be more strongly polar than unoxidized hydrocarbons, which perhaps explains why a mild oxidation of an oil may improve its lubricating quality. The author reports some experiments showing how addition of various fatty acids to medicinal paraffin reduces static friction when used as a lubricant.

ABSOLUTE COLOR MEASUREMENT OF MINERAL OIL.—E. L. Lederer, in PETROLEUM, vol. 31 (1935), No. 21, pp. 1–4.

From the theory of light absorption a formula is deduced for characterizing the color of an oil by two constants; color depth (F_1) and color tone (F_2). These may be obtained by calculation, but more simply by graphing on a special system of coordinates (see diagram).



Color depth is defined as the logarithm of the extinction coefficient at the point of maximum intensity in the solar spectrum (530 mu); color tone is the tangent of the angle of inclination of the straight line representing the logarithm of the extinction coefficient in the specific coordinate system. The greater the quantity F_2 the larger the red and the smaller the yellow components of the color; the greater F_1 the darker the color; bright oils have values around 0. This method of characterization allows of conclusions being drawn regarding the bleaching process, artificial ageing, etc. The absorption measurements are made over the widest possible range of the solar spectrum with the Pulfrich multistage photometer.

In the diagram D represents an unbleached and D^1 a bleached German oil; B, a bright stock; S, a synthetic "kogas" oil; N, a Pennsylvania neutral oil and W a Western bright stock.

VISCOSITY OF HYDROCARBON SOLUTIONS OF GASES.—B. H. Sage, J. E. Sherborne and W. N. Lacey, in IND. ENG. CHEM., vol. 27 (1935), No. 8, pp. 954–956.

When hydrocarbon gases are dissolved in liquid hydrocarbons, marked decreases in density, surface tension, and viscosity result. Such changes have an important bearing upon the processes involved in the production of crude petroleum. It is therefore of interest to obtain sufficient experimental information to permit the prediction of such changes as functions of the properties of original oil and gas involved, of temperature, and of equilibrium pressure. The present paper deals with results of a study of viscosity changes resulting from solution of methane and of propane in an oil known as crystal oil, under conditions of equilibrium, temperature and pressure commonly met in petroleum production practice. The data are exhibited in a series of five graphs.

DIELECTRIC CONSTANTS IN THE OIL INDUSTRY.—R. Buell, in OEL UND KOHLE, vol. 11 (1935), No. 29, pp. 499–503.

In this paper the author notes the usefulness of dielectric measurements as a welcome addition to the growing list of physical methods applied to the examination of oil products. All hydrocarbons have their own specific dielectric constants, which can be sharply distinguished by a good "dielectrometer," which is accurate to the second or third decimal. Oils of different origins, and different fractions of the same oil can be differentiated, and the dielectric constant is definitely related to viscosity. By combining dielectric measurements with determinations of refractive index, inferences can be drawn as to the compositions of a series of distillates. A continuous record can be obtained by installing a suitable dielectrometer in the distillate stream. One interesting application is a rapid method of determining water in an active carbon used as an absorbent.

A MICRO-VISCOSIMETER.—F. M. Lidstone, in JOUR. SOC. CHEM. IND., vol. 54 (1935), No. 25, pp. T. 189–T. 190.

In the course of events in an oil research-laboratory, it may become desirable to ascertain the viscosity of an oil when only a very small sample is available. For meeting this contingency the author has devised a micro-viscosimeter that can be used with 1/20th of a cubic centimeter. The instrument is a simplified form of the absolute viscosimeter, giving values in absolute units by means of a special form of the Poiseuille equation. It is composed of a 35-mm. capillary tube graduated in millimeters. The lower end is dipped in the oil and the time required for the liquid to rise between two points is noted. The whole apparatus is enclosed in a suitable thermostat.

LABORATORY DETERMINATION OF OCTANE NUMBER.—Richard Heinze and Maxmillian Marder, in ZEIT. ANGEW. CHEM., vol. 48 (1935), p. 335.

The "parachor" (as previously defined by Marder) of a hydrocarbon is a function of its chemical composition. This property is greatest in normal (straight chain) hydrocarbons; side chains, double bonds and rings depress it. In the case of hydrocarbons of the same boiling point the value decreases in this order: paraf-

fins, unsaturates, naphthenes, aromatics. In mixtures of hydrocarbons the parachores are additive. The knocking tendency of hydrocarbons increases in about the reverse order given above, that is, from the aromatics up to the paraffins. Therefore, in the case of compounds with the lower and medium parachores, the octane number can be computed from boiling data and the parachor with an accuracy of one unit; for higher parachor values the range of accuracy is five units.

Hence, for a laboratory determination of the octane number, it is only necessary to know the gravity, the boiling data and the surface tension; the latter is best determined by Ubbelohde's capillary method.

Petroleum Chemistry

Composition of Hard, Synthetic Paraffins.—H. Koch and G. Ibing, in BRENNSTOFF-CHEMIE, vol. 16 (1935), No. 8, pp. 141–148.

Paraffins found in synthetic petroleum obtained by the Fischer-Tropsch process were fractionated by the use of differential solvents. No pure compounds could be isolated, but fractions were obtained having similar molecular weights. By using chloroform as solvent, complexes were obtained having chains with up to 150 carbon atoms, with melting points up to 116° C. When the melting points of the different fractions are graphed, there is obtained an asymptotic curve, the upper limit of which occurs at about 118° C., from which it is inferred that the melting point of any saturated chain hydrocarbon will not exceed 118° C., irrespective of the number of carbon atoms in the molecule.

Aside from the high melting points of these synthetic paraffins it is interesting to note that they may have molecular weights up to 2,000; such large molecules are not encountered in the natural crude petroleums.

Thermal Reactions of Gaseous Hydrocarbons.—Gustav Egloff and Edith Wilson, in IND. ENG. CHEM., vol. 27 (1935), No. 8, pp. 917–933.

From an extensive survey of the products obtained over the whole temperature range of thermal reactions of gaseous hydrocarbons, the authors have come to regard ethylene as the basic hydrocarbon. The detailed nature of its thermal reactions gives the key to the decomposition of any hydrocarbon, since ethylene is an important product below 750° C. and since above 750° C. the products are essentially those of ethylene at that temperature.

By a consideration of five types of reactions for ethylene—(1) polymerization, (2) hydrogenation to ethane, (3) scission of one carbon-hydrogen bond, (4) scission of the double bond, and (5) dehydrogenation to acetylene—the reaction products may be accounted for. Determined or estimated values for the energy of activation for these reactions show inconsistencies arising chiefly from the assumption that ethylene is stable below 1000° C.

Polymerization of ethylene to nonaromatic liquids appears to take place by a combination of vinyl radicals or ethylene molecules. Experimental evidence does not support the formation of higher olefins by combination with methylene radicals.

The mechanism for the formation of aromatics from ethylene has not been definitely established. Since dehydrogenation of cyclohexane to give benzene does not occur to any appreciable extent without a catalyst and since the formation of acetylene takes place largely at temperatures higher than the temperatures for the formation of aromatics, a combination of six methylene radicals with the expulsion of six hydrogens due to localized energy has been suggested as a possible source of aromatics.

Determination of Paraffin in Asphaltic Mineral Oil.—A. Zwergal in OEL UND KOHLE, vol. 11 (1935), No. 25, pp. 431–433.

Ten to 15 grams of crude oil is distilled at ordinary pressure in a special copper flask with a long neck and a long copper side tube. The distillation is carried on at 250°–275° C. until all volatile products are driven off, whereupon a weighed receiver is connected with the delivery tube and the system evacuated to one millimeter of mercury. The contents of the copper flask are now heated, at first with a small flame and finally with a Teclu burner. A weighed portion of this second distillate is dissolved with 20 cc. of chloroform, treated with 20 cc. of tricresol, cooled to –20° C., filtered, the paraffin is washed with chloroform and ether-alcohol, redissolved in benzole and finally recovered in a weighed flask by evaporation. The high vacuum is necessary to avoid destruction of paraffin, which would lead to low analytical results.

Improved Methods of Examining Mineral Oils, especially the high Boiling Components.—J. C. Vlugter, H. I. Waterman and H. A. van Westen, in JOUR. INST. PETROL. TECHNOLOGISTS, vol. 21 (1935), No. 141, pp. 661–676.

A new method is given for analyzing hydrocarbon oils of the type of lubricating oils. The results of the analysis are given as: percentage aromatic rings, percentage naphthenic rings, percentage paraffins (free paraffins and paraffinic side-chains). The analysis is effected without any chemical or physical separation between groups of hydrocarbons.

Aromatic rings are determined from the change in physical constants on complete hydrogenation, naphthenic rings and paraffins from the properties of the completely hydrogenated oil.

Because a large number of oils have been examined by the authors, actual hydrogenation has become superfluous, as the constants of the completely hydrogenated oil may be predicted from those of the original oil. Only molecular weight, refractive index, density, and aniline point need be known to calculate the composition of an oil.

Oxidation of Mineral Oils with Gaseous Oxygen at Medium Temperatures.—G. Muller, in COMPT. REND. ACAD. SCI. FRANCE, vol. 200 (1935), p. 1769.

The aging of a transformer oil was studied by noting the volume of oxygen it would absorb at a temperature of 110° C. It was noted that over-refined white oils took up the most oxygen; moderately refined oils took up the least, whereas insufficiently refined oils showed a greater absorbing power. There thus appears to be a distinct "refining optimum." In highly refined oils copper stearate has only a mild action as a catalytic accelerator. During the oxygen treatment there are formed solid, liquid, and volatile oxidation products, among which are noted water, carbon monoxide and dioxide, formic acid, and gaseous hydrocarbons. The number and nature of these oxidations varies greatly in different oils, but remains closely dependent on the volume of oxygen absorbed. In over-refined oils it appears that peroxides are formed as intermediate products, as the gums are attacked. The quantity of solid oxidation products (slime) is not in any fixed relation with the absorbed volume of oxygen. The total quantity of these oxidation products, however, varies greatly with the treatment that the oil has undergone in the refinery.

Pipe Lines

Variable Generator for Lighting Drilling Rigs (and for other purposes),—W. C. Layne, in OIL WEEKLY, vol. 78 (1935), No. 8, pp. 38–40.

During the last two years a demand has arisen in the oil industry for an electrical generator that will supply energy at a constant voltage when driven at widely varying speeds. The two distinct fields for such a generator are the lighting of drilling rigs powered by internal combustion engines mechanically connected to their load, and the generation of electric current by wind power for the protection of pipe lines from electrolysis.

Until this demand arose, the electrical engineers were disposed to think that no such generator could be built because of the indefinite increase of voltage that occurs when the speed of the driving machine is increased. However, by the use of a "thyrite" gate, made of a material that is said to prove that Ohm's law is not universal, it has been found possible to balance exciter voltage and field strength in such a manner that a constant current is produced. Units of 1½ to 7½ kilowatts at a number of speed ranges are now available.

New Practice in Pipe Conditioning.—N. Williams, in OIL & GAS JOUR., vol. 34 (1935), No. 5, pp. 14–42.

The present practice of the Houston Pipe Line Co. is to use a quick-drying hot asphalt coating to which is applied an inhibitor grease to prevent absorption of water. The asphalt-coated pipe is then wrapped with a 30-lb. kraft paper, which serves two purposes: to protect the coating in handling and backfilling, and to facilitate the detection of "holidays" or pin-holes in the coating that might serve as centers of corrosion. A new form of double acting holiday detector has been developed. This is made of hinged metal bands which fasten around the pipe and which are provided with copper brushes and rollers for moving along the pipe length; electric current is supplied by dry cells and Ford tension coils. The asphalt being soft, the

brushes and rollers would soon be gummed up were it not for the paper wrapping. On the other hand, the scratching noise of the brushes moving along the paper drowns the sounds of the spark as it jumps from the brushes to the pipe. The problem is solved by the use of an auxiliary portable radio set which is carried along the job. Although not noticeable to the man moving the detector the static sound of the spark is picked up by the receiver and is loudly audible to a man wearing an ear set. The use of the auxiliary radio receiving set has also facilitated detection of a greater number of holidays on unwrapped enamel coated pipe. Smaller holidays can be detected and the apparatus can be operated at a faster rate.

Dust Hazards at Compressor and Pumping Stations.—F. B. Taylor, in OIL WEEKLY, vol. 77 (1935), No. 11, pp. 31–34.

Although dust storms in the western plains area of the United States are nothing new, their occurrence has lately been on such a grand scale as to be a serious menace. One of the most acute of the problems presented by these unabating storms is adequate filtration of air supplied to power units. Two types of air cleaners have been found satisfactory. The dry cleaners operate by passing the dust-laden air through a bed of porous material, such as glass wool. The wet cleaners use either a finely atomized spray of some liquid to precipitate the dust, or cause the air to traverse an intricate path through vanes or baffles that are kept constantly wet. Aside from these devices removable canvas covers, moistened with light engine oil, may be placed over exposed units. Greases and lubricating oils have to be kept in air-tight containers.

Uses of Petroleum

French Specification for Aeroplane Motor Fuel.—Estradere, in REV. COMBUST. LIQUIDES, vol. 13 (1935), p. 98.

The following requirements are laid down: On distillation 10 to 20 percent must pass over at 75° C., 90 percent at 150° C., and 100 percent at 180° C. Vapor pressure at 37.8° must not exceed 0.5 kg. No precipitation must occur above −45° C. Content of resin must not exceed 6 milligrams in 100 cc. Octane number in the C.F.R. motor must be between 70 and 80.

Effect of Tetraethyllead on Pre-Flame Reactions in an Engine.—Lloyd Withrow and Gerald M. Rassweiler, in IND. ENG. CHEM., vol. 27 (1935), No. 8, pp. 872–879.

Since the introduction of tetraethyllead as an anti-knock compound, there has always been a considerable amount of curiosity about the chemical reactions that occur when the knock is suppressed. There has been strong evidence that lead in some way inhibits pre-flame reactions, but this was a question that could only by settled by an actual study of combustion in an engine. The authors have succeeded in this difficult matter and by the use of spectroscopic methods have demonstrated that lead does influence pre-flame reactions. It seems that the lead is reduced to the atomic condition in that portion of the charge that otherwise would inflame at the time of knock; it is evidently this reducing action that prevents a too rapid combustion.

Lubricating Problem in Airplane Motors.—S. D. Heron, in JOUR. SOC. AUT. ENG., vol. 36 (1935), p. 201.

The more exacting the requirements put upon airplane engines, the more difficult becomes the cooling problem and the heavier the necessary apparatus. To meet the problem it is proposed to increase the allowable radiator temperature from 85° C. to 104° C.; this will allow building of a radiator that is both lighter and of simpler construction. Lubricating oils that will be suitable for this new specification can no doubt be obtained by a suitable refining process. The stability of such oils is a matter for careful study.

Results with the Thomas Oil-Testing Machine.—E. H. Kadmer, in OEL UND KOHLE, vol. 11 (1935), No. 25, pp. 434–437.

The Thomas oil testing machine consists of two revolving shafts or rolls placed one above the other at a right angle; the two rolls thus touch at only one point. At the point of contact they are enclosed in a box which serves to contain the oil to be tested. The upper roll serves as the measuring roll and revolves at 50 r.p.m., the lower cross roll at 300 r.p.m. When set in motion the rolls are axially displaced a little, so that their point of contact describes a spiral path. By means of a lever the upper roll can be pressed against the lower one; this pressure may be varied from 0.2 to 4 kg., using a sliding weight on the lever arm. To the measuring roll is attached a torsion friction balance from which the "friction values" can be read in grams. The bath may be heated electrically so that observations may be made at different temperatures or at a constant temperature. Further, the rolls may both be made of any metal or of different metals so that friction values may be obtained for any combination of metal bearings with any lubricating oil. The arrangement therefore allows of a very wide range of comparisons, especially since the rolls may be operated through any practicable range of the same or differential speeds.

By the use of this machine the relative lubricating values of different oils may be quickly measured. Experience so far has confirmed the lubricating value of fatty oils as additions to mineral oils. Especially noteworthy is the high lubricating value of an aqueous sugar solution, although this substance hardly comes into practical consideration because it does not resist aging.

Very interesting are the results obtained with rolls of various metals. Following are some relative figures for "friction value":

White metal No. 20	(43.5)
Zinc alloy	(47)
White metal No. 5	(52)
White metal No. 80	(55)
Soft cast iron	(63)
Aluminium alloy	(63.3)
Nickel bronze	(66)
Aluminium bronze	(67)
Brass	(67.3)
Hard cast iron	(70.6)
Steel, R.M. 4	(76.3)

Petroleum Economics

Oil Taxes and Oil Profits.—Oskar Tokayer, in PETROL. PRESS SERVICE, vol. 2 (1935), No. 14, p. 8.

In most countries of the world the taxation of petroleum products has, during recent years, reached a level at which it can only be described as extortionate. The fact that, up to the present time, consumers generally have failed to resist this widespread tendency to increase the tax burden on this essential material of civilization, is no doubt due to ignorance of the facts and a lack of organization, coupled with the fact that the relatively low level of prices of petroleum products has largely masked the inordinate proportion of taxation that they bear. This victimization, however, does not end with the consumer. The extent of the financial sacrifice made by the shareholders in oil companies all over the world is seldom realized or understood except by the sufferers themselves.

The following table, based on the reports of a number of the more important oil companies of the United States will illuminate the position (figures in thousands of dollars).

	Net Profit	*Taxes Paid*	*Gross Income*	*Taxes in % of Gr. Income*
Standard Oil (N. J.) [1]	45,619	77,038	1,017,973	7.6
Socony-Vacuum [2]	24,282	64,976	469,147	13.9
Standard Oil of Calif.	18,328	22,577	130,986	17.2
Continental Oil	10,859	18,380	65,721	28.0
Texas Corpn.	5,694	70,000	272,619	25.7
Gulf Oil	2,811	50,843	223,406	22.4
Pure Oil	855 [3]	25,000	79,789	31.3
Shell Union Oil	1,354 [3]	48,210	186,706	25.8

[1] Taxes paid in U. S. A. only. [2] Including taxes on capital. [3] Loss.

Reports of other oil companies show the same state of affairs. The point is that in no case does the profit equal or approximate the amount paid in taxation. For instance, the companies tabulated above show a net profit of $101,702,000 in 1934, and have paid in taxes $377,015,000. Since profits distributed to shareholders are diminished by taxes on dividends it is evident that the treasury receives four to five times more than the shareholders.

Even at that, taxation in the United States is on a comparatively modest scale. The chairman of the Shell Transport and Trading Company has stated that the Royal Dutch-Shell group has paid various foreign governments £57,000,000 while dividends have been approximately £9,000,000, or not quite a sixth of the tax payments.

California Oil Reserves.—J. Edmund Eaton, in OIL WEEKLY, vol. 78 (1935), No. 3, pp. 23–28.

A survey of present conditions leads to the conclusion that the supply of refinable crude in California may fail to equal demand in 1941 unless appreciable new reserves are uncovered. The total visible supply in California, as of April 1, 1935, is indicated to be in the neighborhood of 7,586,000,000 bbl., of which approximately 3,290,000,000 bbl. remains to be produced. The townlot production will decline more or less steadily from 1936 on, necessitating a rapid transfer of both cumulated and future demand on the spaced fields, which have been partly protected from heavy drain. These fields must be stepped up in seven years from 130,000,000 bbl. a year to approximately 230,000,000, the latter figure representing

about the yearly new discovery required to maintain a safe margin. California appears to have vast prospective reserves, but these will have to be proved; heavy prospecting is expected to be resumed in 1936.

Power Alcohol Developments in Europe.—Oskar Tokayer, in PETR. PRESS SERVICE, vol. 2 (1935), No. 11, pp. 1–3.

In the course of a few years alcohol has come to have an importance among motor fuels which it could never have obtained on its own merits in free competition. The factors which have brought about this situation include a general desire to give financial relief to agriculture by affording a market for products that otherwise could find little or no outlet. Another strong reason is that countries which produce little or no petroleum within their own territories find that compulsory use of home-produced alcohol is of assistance in keeping down imports of foreign petroleum, and to that extent helps to relieve the exchange situation which in many of these countries presents grave difficulties.

As a rule, the governments decree the percentage of alcohol which is required to be mixed with all motor fuel and make rules as to the manner of blending; some governments merely fix the quantity of alcohol which the oil companies must buy, while leaving them free to decide whether or how they shall use it; such an arrangement prevails in France, Germany, Italy, Austria, Poland, Sweden, Spain and Jugoslavia. The result is a hodge-podge of blends of different characters at different filling stations, giving rise to much complaint among the consumers. In Latvia, Hungary and Czechoslovakia the percentage of alcohol to be contained in all motor fuel is prescribed by law. Legislation to compel the use of motor-alcohol is pending in Lithuania, Bulgaria, Irish Free State, Netherlands, and Esthonia. Only in Belgium, Luxemburg and Finland has the motor-alcohol proposition been turned down for economic reasons.

There is no law compelling use of motor-alcohol in Great Britain, but some is being used in that country on account of a higher duty on gasoline.

The prescribed mixing ratio varies greatly from one country to another, but in most cases it is between 10 and 25 percent. The price of motor-alcohol is fixed by the government, and ranges between two and 10 times the price of gasoline.

In 1934 the quantity of alcohol employed for power purposes in the countries here named, where such use is compulsory, was about 5,569,000 hectoliters (about 3,500,000 bbl.).

Motor Vehicle Production in 1934.—Oskar Tokayer in PETROL. PRESS SERVICE, vol. 2 (1935), No. 14, p. 10.

Quoting the League of Nations' Economic Intelligence Service, it is stated that the world produced nearly twice as many motor cars and lorries in 1934 as in 1932. The figure was 3,745,000 as against 1,979,000, but it is still far short of the 1929 peak of 6,315,000. The U. S. A. production is still the predominant factor. The figures for the years 1934, 1932, 1929, being 2,779,000, 1,370,000 and 5,358,000, the figures for the rest of the world therefore are 996,000, 608,000 and 857,000, showing that while still far behind the U. S. A., the rest of the world is catching up, and exceeded in 1934 the 1929 peak.

Books

Petroleum Development and Technology, 1935.—Published 1935 by Am. Inst. of Mining and Metallurgical Engineers, New York; 554 pages, $5.00.

This is a collection of papers and discussions presented before the Petroleum Division of the A.I.M.M.E. at Tulsa in October, 1934, and at New York in February, 1935. The chapter on Production Engineering and Engineering Research comprises 12 papers not heretofore published in any other medium, the chapter on Use of Metals in the Petroleum Industry has eight, on Stabilization three, Petroleum Economics five. The chapter on Production contains an introduction by Frank A. Herald, 18 papers on production in as many States and separate papers on each of the eight oil districts of Texas. Then there are 20 reviews of production in that many foreign countries; each of these reviews is by an authority familiar with the region under consideration. The closing chapter is on developments of Refining Engineering in 1934, by Walter Miller. The book is unquestionably worth possessing and reading, both by the oil engineer and the oil economist. The papers on strictly production engineering have been chosen so that oil engineers will find at least one important treatment of each major division of operations.

Drilling and Production Practice, 1934.—Published 1935 by American Petroleum Institute; $2.

This is the initial volume of an annual series of "Production Year Books" to be issued by the A.P.I. The 200-page book contains papers on drilling and production practice, selected by the Program Committee of the Institute's Central Committee on Drilling and Production Practice from those presented before national and district meetings of the Division of Production during the year. The volume thus preserves for convenient use the outstanding papers on such subjects as allocation of production, geology, equipment, drilling practice, production practice and general. Included is an index of all papers presented before the Division of Production since December, 1927.

Petroleum—The Story of an American Industry.—Published 1935 by American Petroleum Institute; 15 cents.

This is a new and enlarged edition of the Oil and Oil-Industry series of booklets issued by the A.P.I. There are here presented essential facts concerning the history and services of the American petroleum industry, told in as simple as possible terms for the lay reader. It deals particularly with the industry's accomplishments, and attempts to explain its place in the economic picture.

Chapters given over to petroleum refining, taxation, and conservation are entirely new, and present the latest picture of these phases of the industry's activities. Included in the chapters on refining is the Institute's refinery "flow chart," for which there has been enormous demand.

The chapter on taxation includes tables showing how taxes have affected the industry and its customers over long periods. The chapter on conservation recounts the industry's own efforts to protect the nation's petroleum reserves. Chapters on transportation and storage, marketing, and motor fuel have been revised and, like the entire book, brought up to date.

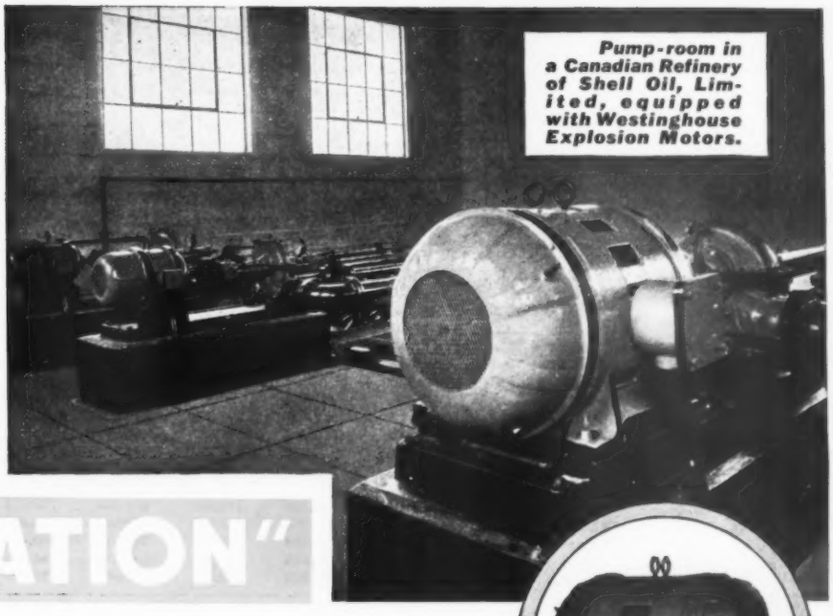
The book has been published to promote better understanding of the petroleum industry by the general public; and, with this objective in view, explains not only the services rendered by the industry, but also the how and the why of its operations.

Le Petrole et son Economie (Petroleum and its Economics).—Henry Peyret and numerous others, with an introduction by Louis Pineau, published 1935 by Librairie Tech. et Econ., Paris; 224 pp., 132 figs.; 30 fr.

This timely book contains a series of short studies of various aspects of the world-wide petroleum industry. By chapters the topics treated are: Characteristics of the World Petroleum Market, by H. Peyret; Technical Concepts, by Robert Couran· Crude Oil Deposits, by Charles Bihoreau; The World Refining Industry, by G. Ermakoff; Finished Products, Their Commerce and Use, by J. Filhol; Maritime Transport of Petroleum, by R. C. Julien; Oil Transportation, by L. Chove; The Great Oil Trusts and Government Corporations, by Filhol; The United States Oil Market and the Roosevelt Code, by L. de Miramon-Pesteils; Petroleum in the Far East (Japan, Manchoukou, China), by Peyret; Organization and Development of the Soviet Oil Market, by Peyret; British Oil Market, by Cecil W. Wood; German Oil Market, by Peyret; Roumanian Oil Market, by Mihail Pizanty; Italian Petroleum Situation, by Giulio Bosco; Spanish Oil Market, by Jose A. Alvarez; French Petroleum Market, by Peyret; Iraq and the Compagnie Francaise des Petroles, by M. Mercier; The Petroleum Fiscal Regime, by J. Hamel; Petroleum and the Capital Market, by R. Cadot; Petroleum and Technical Standardization, by H. Weiss; Petroleum and Commercial Standardization, by XX; Future of Petroleum, by R. Brunschwig. These 23 chapters include a wide range of statistical and other information, collected by authorities in the several fields, and should prove of interest and value to oil men who read French.

Chemistry of Petroleum Derivatives.—Carleton Ellis; published by Chemical Catalog Co., New York; 1285 pages; $18.

This enormous book contains "as comprehensive a review of the chemical derivatives of petroleum as publication limitations (1285 pages!) permit." No short review can give an indication of the staggering amount of information packed between its covers. The author's range covers not only motor fuels and lubricants but includes a vast list of useful commodities: insecticides, extraction agents, soaps, raw materials and reagents, solvents, non-fading dyes, adhesives, odorizers, preservatives, medicines; the list of possible uses of petroleum hydrocarbons—either alone, in compound, or as processing agents—might be extended indefinitely.



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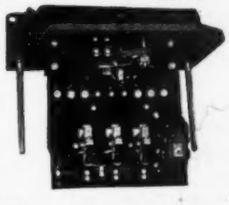

are above the oil level to assure accurate calibration for overload protection. The oil film covering all parts within the enclosure protects them from corrosion. Designed for use in locations where corrosive, as well as explosive, gasses are present.

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World Oil Production—Official Figures for 1934 and 1935 Revised

All figures furnished direct to WORLD PETROLEUM by Governments, except where otherwise specified

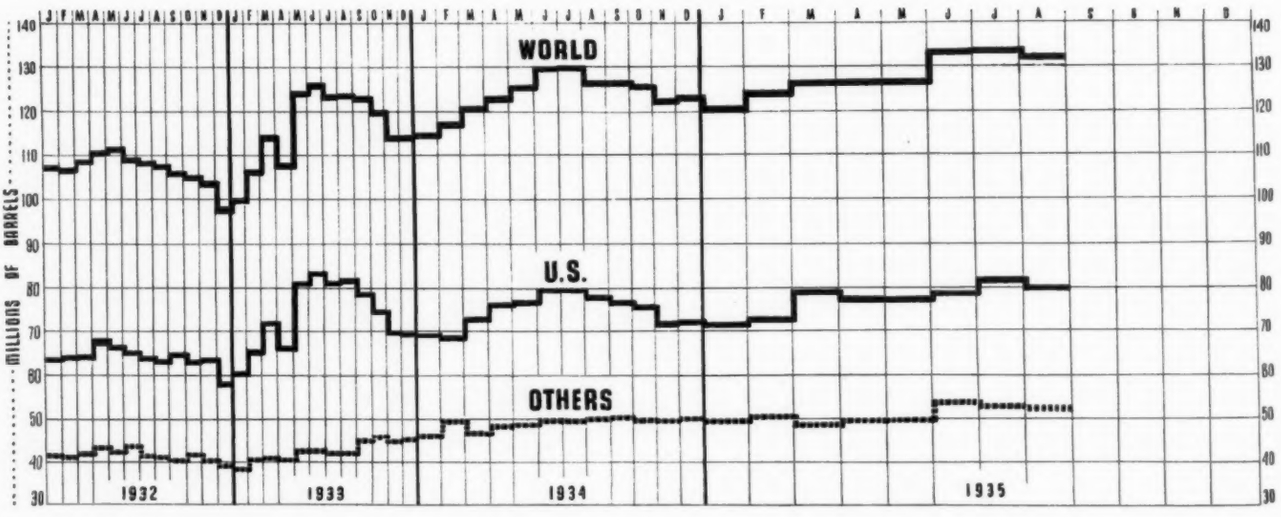
(Figures in U. S. Barrels—Conversion ratio 7 bbl. = 1 ton)

Country	September 1934	October 1934	November 1934	December 1934	January 1935	February 1935	March 1935	April 1935	May 1935	June 1935	July 1935	Provisional Figures August 1935
United States	75,810,000	76,776,000	72,463,000	74,772,000	78,715,000	72,763,000	81,488,000	78,427,000	82,454,000	82,338,000	85,485,000	82,071,508
Russia	13,924,400	14,260,000	14,388,500	14,638,400	13,358,100	12,704,300	14,139,300	14,058,200	14,280,000[1]	14,150,000[1]	14,050,000[1]	14,230,000
Venezuela	12,381,159	12,591,390	12,274,794	12,420,296	12,818,414	11,287,605	11,703,825	11,869,900	12,175,022	13,075,118	13,429,885	12,628,067
Iraq[5]	11,618,510	12,006,127	11,618,510	12,006,127	425,000	1,631,000	2,258,123	556,500[1]	1,085,000[1]	4,200,000[1]	1,739,348[1]	1,739,255
Roumania	5,335,000	5,467,000	5,324,000	5,522,000	5,355,000	4,860,000	5,256,000	5,008,000	5,035,000	4,842,000	5,075,000	5,213,301
Iran[3]	4,955,419	4,499,530	3,725,178	4,049,556	4,410,714	4,109,665	4,879,000	4,088,000	3,927,000	4,264,480[1]	4,249,000	4,634,000
Mexico	3,276,612	3,393,770	3,332,926	3,425,314	2,894,167	2,661,632	3,519,148	3,120,035	3,529,659	3,453,871	3,573,632	3,570,908
Netherland India	3,410,785	3,577,399	3,553,067	3,743,810	3,618,272	3,244,717	3,539,564	3,438,848	3,517,360	3,463,061	3,531,857	3,699,430
Colombia[4]	1,627,632	1,646,293	1,633,654	1,554,172	1,653,647	1,141,696	1,466,821	1,377,299	1,486,896	1,518,460	1,639,054	1,567,307
Argentina	1,258,812	1,271,186	1,283,811	1,173,998	1,114,235	1,107,420	1,260,468	1,514,968	1,203,017	1,161,638	1,198,550	1,263,994
Peru[4]	1,415,189	1,485,309	1,340,115	1,420,247	1,418,320	1,269,077	1,395,532	1,329,215	1,451,436	1,414,588	1,448,225	1,272,038
Trinidad	919,469	906,152	907,655	930,877	915,220	843,619	919,848	899,946	953,108	972,904	988,341	1,003,382
British India	752,451	779,011	763,091	746,410	781,170	708,159	773,572	700,000[1]	700,000[1]	700,000[1]	700,000[1]	700,000
Poland	311,003	315,000	308,000	308,000	307,000[1]	297,000[1]	309,000[1]	330,000[1]	340,000[1]	314,490[1]	324,973[1]	274,040
Brunei	246,554	225,561	227,815	258,909	269,794	241,927	264,390	267,603	277,550	269,290	283,430	281,400
Sarawak	155,400	156,800	152,600	158,200	183,300	136,500	152,250	151,067	155,400	150,850	151,830	154,000
Japan	124,870	125,229	119,970	131,059	171,441	151,797	164,174	167,728	154,150	144,160[1]	146,863	154,000
Egypt	124,502	123,235	116,326	115,731	112,147	100,086	104,419	94,955	100,555	99,260	103,488	104,937
Ecuador	136,033	141,079	133,490	140,000	147,315	139,555	151,366	145,212	147,245	137,806	144,812	135,549
Canada	114,242	122,056	113,228	117,113	124,654	111,545	120,537	108,506	122,636[1]	120,102	118,812	120,000
Germany[6]	198,366	227,605	219,485	228,767	287,518	223,153	277,942	240,464	285,747	257,369	276,990	235,501
France	46,000[1]	46,000[1]	46,000[1]	46,000[1]	43,078	34,510	44,191	46,284	46,991	46,000	45,276	46,312
Others[1]	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000
Total	138,217,408	140,216,732	134,120,215	137,981,986	129,198,506	119,842,963	134,262,470	128,014,730	133,502,772	137,168,447	137,779,866	135,173,929

[1] Estimate. [2] Anglo-Persian Oil Co. figures revised; fuel oil returned to the ground has been deducted. [3] Thuringia estimated 7,000 bbl.; official figure for Prussia. Russian Sakhalin included with Russia. Japanese Sakhalin included with Japan. [4] International Petroleum Company's figures. [5] Iraq production estimated for 1934 on basis of total year's production represented by oil shipments through Tripoli and Haifa starting January 1935 plus oil necessary to fill line initially. [6] International Petroleum Company and Lobitos Oilfields Ltd. figures.

Official Crude Oil Production Figures for 1932 to 1935

Country	Total 1935 to August 31	Daily Average 1935 to August 31	Total 1934	Daily Average 1934	Total 1933	Daily Average 1933	Total 1932	Daily Average 1932
United States	643,741,508	2,649,142	909,107,000	2,490,704	898,874,000	2,462,670	785,159,000	2,145,243
Russia	110,969,900	456,667	168,648,700	462,051	149,901,900	407,950	149,719,000	409,070
Venezuela	98,987,836	407,357	142,072,329	389,239	120,882,802	331,186	119,596,512	326,766
Iraq	13,634,226	56,108	71,921,468	6,607	1,200,000	3,288	1,200,000	3,300
Roumania	40,644,301	167,260	62,006,000	169,879	50,971,200	139,647	50,491,205	137,954
Iran	34,561,859	101,078	52,663,782	144,284	49,581,280	135,840	45,122,455	123,285
Mexico	26,323,052	108,325	38,167,022	104,567	33,904,882	92,890	32,802,285	89,624
Netherland India	28,053,109	115,445	42,289,408	115,861	38,512,663	105,516	39,584,027	108,153
Colombia	11,851,180	48,770	17,340,724	47,509	13,157,127	36,047	16,384,956	44,768
Argentina	9,824,290	40,223	14,045,652	39,015	13,759,565	38,232	13,166,900	35,975
Peru	10,998,431	45,261	15,936,937	43,663	13,923,281 −	38,146	9,899,266	26,026
Trinidad	7,496,368	30,849	10,894,363	29,847	9,560,039	26,192	10,023,780	27,387
British India	5,762,901	23,712	8,997,399	24,650	8,721,655 +	23,893	8,600,312	23,500
Poland	2,496,503	10,274	3,697,617	10,130	3,858,085 −	10,570	3,905,230	10,670
Brunei	2,155,384	8,870	2,673,041	7,323				
Sarawak	1,235,197	5,083	1,948,044	5,337	2,289,472 −	6,273	2,274,043	6,213
Japan	1,254,313	5,162	1,484,962	4,068	1,377,761	3,827	1,575,333	4,375
Egypt	819,847	3,374	1,479,037	4,052	1,591,495	4,360	1,742,370	4,760
Ecuador	1,148,870	4,728	1,655,062	4,534	1,622,624 −	4,446	1,573,857	4,300
Canada	946,792	3,896	1,418,810	3,887	1,147,825 −	3,144	1,054,373	2,880
Germany	2,084,684	8,579	2,266,964	6,211	1,712,823	4,692	1,824,019	4,983
France	352,642	1,451	552,000	1,512	552,000	1,515	552,000	1,508
Bahrein			285,071	781				
Others	600,000	2,469	861,000	2,359	432,000	1,184	432,000	1,180
	1,055,943,193	4,345,445	1,502,617,452	4,117,293	1,417,534,489	3,884,022	1,296,712,823	3,544,940



World crude oil production trend by months, 1932–1935. Chart is weighted to compensate for variation in number of days per month. Ratio of U. S. crude production to world production.

OIL COUNTRY

TRADE MARK

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PIPE

Youngstown

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UNITED STATES

	Daily Crude Oil Production bbl.	Daily Runs to Stills bbl.	Total Motor Fuel Stocks bbl.	Imports for week bbl.	California Shipments East for week bbl.
Week ending August 10	2,689,500	2,735,000	58,164,000	646,000**	none
	462,500*				
Week ending August 17	2,743,000	2,740,000	57,512,000	1,600,000**	413,000
	473,000*				
Week ending August 24	2,735,000	2,740,000	56,374,000	526,000**	249,000
	477,500*				
Week ending August 31	2,703,000	2,750,000	55,286,000	792,000**	194,000
	478,000*				
Week ending Sept. 7	2,710,000	2,645,000	55,527,000	1,282,000**	100,000
	483,500*				

Underlined figures indicate improvement in statistical position—decrease in production, runs to stills, gasoline stocks and imports.
*Estimated total production of the East Texas field, official and unreported.
**Import figures include all oil imported, for domestic use and in bond for re-export, it being impossible to make the separation in weekly statistics.

State Developments

JUST BEFORE the recess Congress passed a law approving the interstate oil compact, as requested by President Roosevelt, but refused to enact any further legislation relating to the oil industry in the session just closed.

The organization meeting of the Interstate Compact Commission took place on September 12 in Oklahoma City, with representatives of six states whose legislatures have ratified the compact, including Texas, Oklahoma, Kansas, Colorado, New Mexico and Illinois; Arkansas, Michigan and Wyoming being represented at this meeting by unofficial observers. Governors James V. Allred of Texas, E. W. Marland of Oklahoma and A. M. Landon of Kansas were present. The purpose of the compact was defined as: (1) conservation of natural resources, (2) prevention of waste, and (3) prevention of price fixing within the oil industry. While the meeting was for organization purposes only the general policies were stated by Governor J. V. Allred who said that "We are not going to be a party to any pact or treaty which will penalize the consumer of gas or oil"; and by Homer Hoch, chairman of the Kansas Corporation Commission, who urged "let's confine ourselves to the authority and limitations granted in the bill . . . if we go beyond this we are subject to criticism." The next meeting of the Interstate Compact Commission was set for October 11, to be held also in Oklahoma City.

Of general interest is the fact that the authoritative legal opinion holds the following important New Deal legislation as unconstitutional in the whole or in part: the Wagner Labor Relations Act; the Wheeler-Rayburn Public Utility Holding Company Bill; and the A.A.A.

In Texas on September 8, Federal Judge Randolph Bryant upheld the constitutionality of the Connally Oil Control Bill in refusing the plea of the East Texas Refining Company for an order overruling the Federal Oil Tender Board, which refused to grant the company permission to move 155,000 bbl. of crude oil in interstate commerce.

In California great efforts were being made to reach an agreement between the various factions in order to reduce production and restore the prices, but up to this writing nothing concrete was achieved, though there are great hopes that the situation will be straightened out shortly. On September 18 an emergency advisory board of independent oil producers was in session debating methods of effective curtailment. By the middle of September 560 producers, representing about 83 percent of the state's production, had signed the curtailment agreement, while a group of operators representing about 10 percent of the production always conform with proration regulations without signing, thus apparently leaving about seven percent of production in the hands of overproducers.

Prices Hold

DURING the past month crude oil and gasoline prices remained unchanged in the Mid-Continent area with retail prices at service stations continuing steady east of the Rocky Mountains, due entirely to very high seasonal demand. In California the crude oil prices broke sharply on August 29, when the Standard Oil Company of California reduced the lighter grades by as much as 69 cents a barrel in some cases, with crude oil reduction demoralizing service station prices throughout the Pacific territory. With several difficulties facing the producing branch of the oil industry at this time and with production at record level reaching over 2,800,000 bbl. per day, it is evident that unless this excess production is curtailed forthwith crude oil and motor fuel prices will be reduce d throughout the United States as soon as the seasonal demand slows up. The only favorable factors at this time are: (1) the elimination of Rodessa and Anahuac fields from the class of threatening major fields, though Rodessa may temporarily affect the markets during the coming few months; (2) the passing of the control of Louisiana, where Rodessa field is located, from the hands of Huey Long to politicians who will probably attempt some reconciliation with the oil industry; and (3) the fairly satisfactory enforcement of production in all states, excluding California, and the probability that national production will be reduced shortly to conform with the slow seasonal demand. It must be emphasized, however, that unless production is radically reduced immediately, crude oil prices could not possibly be maintained at the present levels in the Mid-Continent.

During the past month refinery gasoline quotations remained steady, although some weakness was noticeable early in the month immediately following the reduction of crude oil prices in California. Motor fuel prices at service stations were considerably stronger throughout the United States with price wars practically non-existent. Natural gasoline prices advanced to the highest levels since the fall of 1933, influenced by the demand for winter blending. Posted crude oil prices during the past month were firm and unchanged in the southwest at $1.00 per barrel for 36 gravity Mid-Continent crude, and $1.00 flat per barrel for East Texas crude. In California the crude oil prices were sharply reduced by the Standard Oil Company of California on August 29, influenced by very large production above the actual demand and above the recommendations of the Bureau of Mines. The lighter grades, as indicated on the accompanying table, have been principally affected since overproduction is entirely in lighter crude oils. Quotations for low gravity crude oils remained unchanged due to unusually good demand for gas and fuel oils.

Tank wagon/service station motor fuel prices per gallon, regular grade, including all taxes, in representative districts in the middle of September were: 15.05/19.3 cents in metropolitan New York (13.5/17.0 cents in Newark, N. J., up 0.2 cents); 13.0/16.5 cents in Boston, Mass.; 12.0/13.5 cents in Providence, R. I.; 15.5/17.5 cents in Chicago; 17.0/19.0 cents in Ohio; 14.0/16.0, down 2.5 cents, and 11.5/13.5 in San Francisco and Los Angeles respectively, with some independents selling third grade motor fuel for as low as 8 to 10.5 cents per gallon in Los Angeles, all taxes included; 16.0/18.0 cents in Oklahoma; 15.0/17.0 in Dallas, Fort Worth and Houston, Texas, with third grade product from the East Texas field selling locally down to 9–10 cents per gallon by independent stations; 15.2/17.2 cents in St. Louis and East St. Louis, and 20.5/23.0 cents in Montreal, Canada; all with a 2-cent differential for premium grade.

Refinery gasoline quotations in the Mid-Continent area remained steady and unchanged during the past month, it being the fifth month in succession in which refinery gasoline was quoted without any variations. Refinery gasoline was quoted on September

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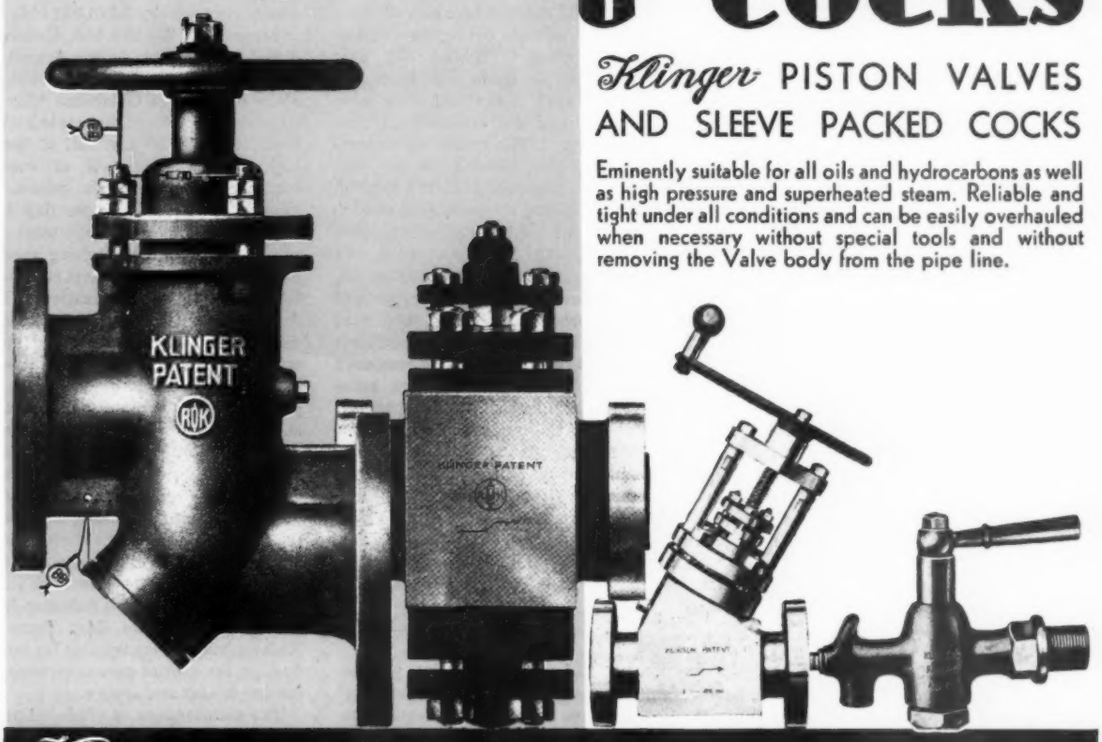

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15 at 4¾–4⅞ cents per gallon for 58–60 U.S.M. grade 62.9 and below octane rating in Group 3, Oklahoma market; 63.0–70.9 octane rating, U.S.M. regular grade, was quoted at 5⅝–5¾ cents per gallon; and 71 and above octane rating, U.S.M., premium grade was nominally quoted at 5¾ cents per gallon. East Texas markets continued with prices on par with Group 3 quotations. On the East Coast, at Bayonne, U.S.M., grade 60.0–64.9 octane rating gasoline was quoted slightly lower at 5¾ cents per gallon (3.40 cents gold *). Gulf Coast prices for export declined ¼ of a cent per gallon below August 15 quotations and on September 15 were around 4⅝ cents per gallon (2.72 cents gold *) for grade 58–60 U.S.M.

Natural gasoline prices advanced as much as 1 cent per gallon during the past month with the gradually increasing fall demand. On September 15 in a very strong market grade 26–70 was quoted at 4⅛ cents per gallon (2.43 cents gold *) in Oklahoma; 4 cents per gallon (2.36 cents gold *) in North Texas; and 4⅜ (2.58 cents gold *) in North Louisiana.

Kerosene prices weakened somewhat during the past month. On September 15 grade 41–43 w.w. was quoted at 3¼–3⅜ cents per gallon in Group 3, Oklahoma market; and at 4⅝ and 4¾ cents per gallon (2.73 cents gold *) on the East Coast at Bayonne. Gulf Coast prices for export remained unchanged at 3⅞ cents per gallon (2.29 cents gold *) for 41–43 p.w. grade and 3⅞–4 cents per gallon (2.36 cents gold *) for 41–43 w.w. grade.

Exports Continue High

DURING July, 1935, total gross imports of all petroleum products into the United States amounted to 4,224,000 bbl., 136,200 bbl. per day, as compared with 4,836,000 bbl., 161,000 bbl. per day, imported during the preceding month; out of this total during July, 1935, 2,508,000 bbl., 81,000 bbl. per day, were imported for domestic use and 1,716,000 bbl., 55,300 bbl. per day, were imported in transit either for refining and re-export or for use in vessels in foreign trade. During the preceding month, June of 1935, 3,478,000 bbl., 116,000 bbl. per day, were imported for domestic use and 1,358,000 bbl., 45,200 bbl. per day, were imported in bond as indicated above. The crude oil imported for refining and re-export amounted in July, 1935, to 479,000 bbl. Therefore during July the net imports of 81,000 bbl. per day for domestic use were well within the federal recommendation of 108,400 bbl. per day.

During June and July of 1935 the exports of all petroleum products from the United States were at the highest level since 1930, due very largely to the extensive war preparations in Europe and consequent demand for gasoline and heavy oil fuels, as well as for crude oil for several large refineries in France, Italy and other countries, completed within the last few years. Exports of all petroleum products during July, 1935, declined 3.24 percent below the daily rate of the preceding month, amounting to 12,925,000 bbl., 417,000 bbl. per day, as compared with 12,951,000 bbl., 431,000 bbl. per day, shipped during June, 1935. The July, 1935, total exports were 25.8 percent in excess of the shipments in July of 1934 when 10,274,000 bbl., 321,000 bbl. per day, were exported. For the first 7 months of 1935 the total exports of 68,962,000 bbl. exceeded by 4.12 percent the exports during the similar period of 1934, when 66,232,000 bbl. were shipped. Exports of crude oil from the United States during June and July were particularly high and did establish all time records. In July, 1935, crude oil exports reached 5,832,000 bbl., 188,000 bbl. per day, as compared with 5,589,000 bbl., 186,000 bbl. per day, shipped during the preceding month; and as compared with 4,128,000 bbl., 133,000 bbl. per day, exported in July of 1934. In July of 1935 crude oil exports constituted, therefore, 45.1 percent of the total exports of all petroleum products. During the first seven months of 1935 crude oil exports amounted to 28,264,000 bbl. as compared with 22,969,000 bbl. shipped in the same period of 1934, an increase of 23.01 percent, thus, even though the independent operators in United States are greatly excited over the relatively small amount of imports into the country, they overlook the fact that the exports from the United States in terms of crude oil currently amount to 540,000 bbl. per day, or equal or exceeding the daily production of either California, East Texas or Oklahoma.

* U.S. dollar at 41 percent discount.

California Crude Oil Prices Before and After August 29 Reduction

	Old	New	Reduction
Long Beach/Signal Hill			
14–14.9 gravity	$0.65	$0.65	none
22–22.9 gravity	0.84	0.55	0.29
30–30.9 gravity top	1.09	0.47	0.62
Playa Del Rey			
14–14.9 gravity	0.65	0.65	none
26–26.9 gravity top	1.04	0.36	0.68
Elwood Terrace			
37–37.9 gravity top	1.15	0.46	0.69
Kettleman Hills			
33–33.9 gravity	0.93	0.62	0.31
39–39.9 gravity top	1.11	0.56	0.55

Production Continues Excessive

CRUDE oil and natural gasoline production during August, 1935, the third month of operations without the federal regulations under the N.R.A., averaged about 2,840,000 bbl. per day, 23,000 bbl. daily under the crude oil and natural gasoline production during the preceding month when 2,863,000 bbl. per day were produced; and it was also about 186,000 bbl. per day above crude oil and natural gasoline production in August of 1934, an increase of 7.00 percent. The August, 1935, average daily crude oil production thus exceeded the federal recommendations by some 140,000 bbl. per day, the great bulk of overproduction being in California which exceeded its quota by 3,170,000 bbl., while Texas overproduced 930,000 bbl. Kansas underproduced 206,000 bbl. during August, and Oklahoma underproduced 780,000 bbl. during the same month, the Oklahoma City field being responsible for all of that state's underproduction. During the first half of September the highly disturbing state of overproduction continued in California where production soared to 634,500 bbl. per day in the week ending September 14, with total overproduction in the country reaching around 200,000 bbl. per day. The overproduction in California resulted in the drastic cut in prices on August 29 and if the production in that state continues at as high a level a further cut in crude oil prices in California will become inevitable. Outside of California the hot oil production in the East Texas field continued at around 30,000 bbl. per day, but on the other hand both Rodessa field in Louisiana and the Anahuac field in Texas witnessed unfavorable developments during the past month, reducing their chances of becoming serious threats to the markets. While the showing of salt water in the Rodessa field is a definite unfavorable factor and eliminates the field from being a major threat to the oil industry for any long period of time, like East Texas field, still Rodessa may be responsible for large overproduction for a brief period of time during the coming winter and spring.

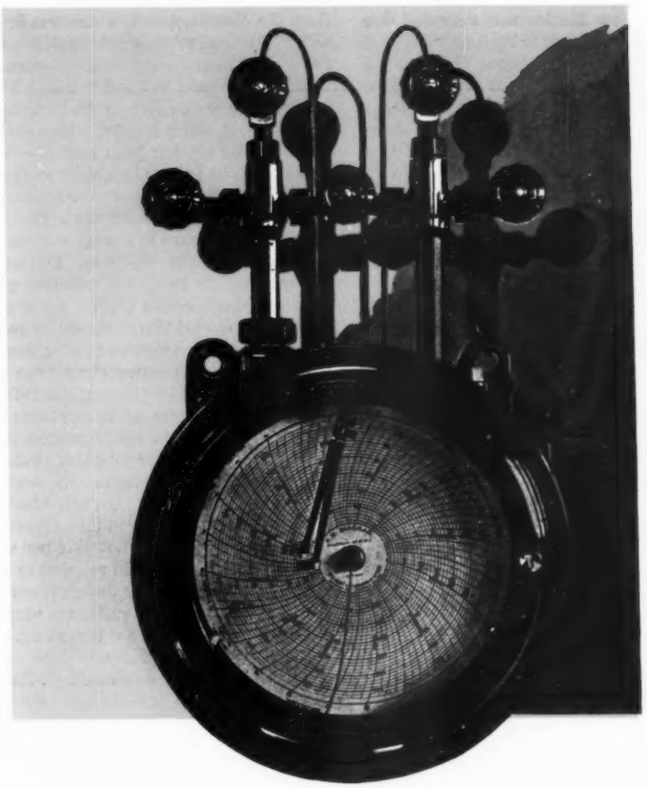
The maintenance of crude oil prices to date in the Mid Continent area has been due entirely to unusually heavy demand for crude oil and its products, both for domestic consumption and for export trade.

Crude oil runs to stills during August, 1935, averaged about 2,730,000 bbl. per day, or some 9,000 bbl. per day under the runs to stills

Effect of Federal Proration Recommendations in Principal Oil Producing States

	Sept. 1933 to Aug. 1935 Cumulative Overproduction		August 1935 Over-production	September 1935 Bureau of Mines Recommended Quota	Daily Average Production for week ending	
					September 7	September 14
	bbl.	% of total	bbl.	bbl.	bbl.	bbl.
Texas	39,335,000	52.2	940,000	1,059,900	1,074,000	1,085,000
Oklahoma	9,560,000	12.7	*	506,000	449,500	493,500
California	13,548,000	18.0	3,170,000	499,700	617,500	634,500
Kansas	2,037,000	2.7	**	151,900	129,000	147,500
United States	75,172,000	100.0	3,670,000	2,613,000	2,710,000	2,752,000

*Oklahoma underproduced 780,000 bbl. in August.
**Kansas underproduced 206,000 bbl. in August.



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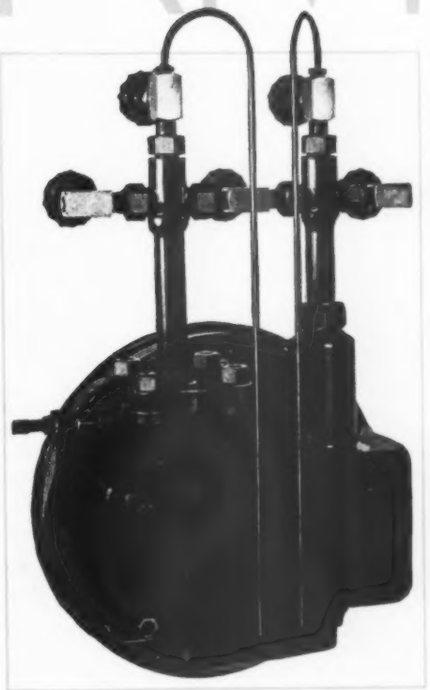

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during the preceding month when 2,739,000 bbl. per day were refined.

Total stocks of all petroleum products declined during July, 1935, by 2,041,000 bbl. to a total of 566,012,000 bbl., indicating daily gross withdrawals of 65,800 bbl.

Motor Fuel Demand High

INDICATED domestic demand for motor fuel during July, 1935, averaged 1,329,000 bbl. per day, an all time record for July, an increase of 5.22 percent above the daily average dur... June, 1935, when 1,263,000 bbl. were co sumed per day; the domestic demand durin July, 1935, was 112,800 bbl. per day above the domestic motor fuel consumption in July of 1934, an increase of 9.28 percent; 139,000 bbl. per day above the adjusted domestic motor fuel consumption in July of 1933, an increase of 11.68 percent; and 33,000 bbl. per day above the adjusted domestic motor fuel consumption in July of 1931, the peak year before 1934, an increase of 2.55 percent.

The NEW YORK TIMES weekly combined business index advanced slightly to 88.5 in the week ending September 7, 1935, from the August average of around 87.5. The NEW YORK TIMES index stood at 75 on September 1, 1934; at 78 on September 1, 1933; at 67 on September 1, 1932; and at 79 on September 1, 1931, thus suggesting a fairly general improvement in the business conditions of the country, though the importance of the federal expenditures on such improvement cannot be overemphasized. Of considerable importance in the improvement of business conditions was the sharp increase in machine tool orders as given out by the National Machine Tool Builders Association. This index, which averaged 155.8 during 1929, declined to below 10 early in 1933 and averaged around 40 in 1933 and 1934; averaged around 65 from January to May of 1935 but has since advanced to 120 by the close of July.

The daily rate of exports of motor fuel dropped slightly to 97,000 bbl. in July, 1935, 9.34 percent below the preceding month; 75.2 percent above motor fuel exports in July of 1933; and 32.8 percent below motor fuel exports in July of 1931.

On August 1, 1935, motor fuel stocks at refineries, plants, terminals and in transit, inclusive of natural gasoline, amounted to 56,288,000 bbl., a decline of 2,704,000 bbl. as compared with stocks on hand on July, 1935, indicating that during July motor fuel demand exceeded supply by 87,100 bbl. per day.

Field Developments

DURING the last month the following important oil field developments took place: (1) the Rodessa field in Louisiana developed salt water production which narrows the producing area of the field to from ½ to ¾ of a mile in width and which probably eliminates the field as a major threat to the oil industry over any long period of time, though the field will be in position to throw on the markets large production for few brief months during the coming winter, if not curtailed; (2) the Anahuac field in Texas was unexpectedly defined in northeastern and southwestern directions thus reducing the original estimates as to size and reserves very considerably; (3) the Monument field in New Mexico was extended due north and due south, now being four miles long and appearing as being larger than Hobbs areally, though not as consistent in production; (4) the Oxford field in Kansas developed deeper flush production of spectacular nature from Simpson dolomite, but the field is areally very small and will not exercise much influence on the crude oil situation or reserves; and (5) the Wilcox sand production of Oklahoma City field continued its rapid decline, with wells that were being actually tested showing a 30 percent decline, while the majority of wells preferred to take 70 percent flat decline from the last April potentials, indicating that in all probability they were unable currently to produce even 30 percent of the preceding potentials, and in fact the field with an allowable of 5,221,622 bbl. in August produced only 4,190,769 bbl.; similarly the drilling campaign on the north end of the field within city limits continued to be most disappointing.

Rodessa, Louisiana

BY THE middle of September the Rodessa field had 23 large gas wells and 3 oil wells, of which one was plugging up after developing around 10 percent of salt water. The second completion in the field was the Haynes Production Company's No. 1 Lawton in section 14, T. 23 N., R. 16 W., 1½ miles due northeast from the discovery well, which was brought in as a 12,000-bbl. producer through 2-inch choke from the Glen Rose oölitic limestone of the upper Trinity at 6,015 to 6,052 ft. The crude oil from this well, however, had a temperature of 130 deg. F. which suggested that the production may be coming from near the oil water contact. The third completion in Rodessa in fact developed salt water production, it being Haynes Production Company's No. 1 Otwell in section 15, same township and range, and located between the discovery well and No. 1 Lawton, which produced 650 bbl. per hour through 2-inch choke from a total depth of 6,081 ft., but rapidly developed 10 percent of salt water and was shut-in to plug back. The importance of the water showing in the Rodessa field cannot be overemphasized: it eliminates the field from being anything like the East Texas, as was freely predicted in the press; it makes it very probable that the production will be characterized by large initials and rapid declines, more particularly if the field is allowed to produce unprorated or above a very minimal allowable per well; and the location of the well in relation to other oil and gas wells and its not too great penetration into the pay formation suggest a very narrow areally producing belt, not exceeding, perhaps, ½ to ¾ of a mile in width.

BASIL B. ZAVOICO

FUTURES MARKET

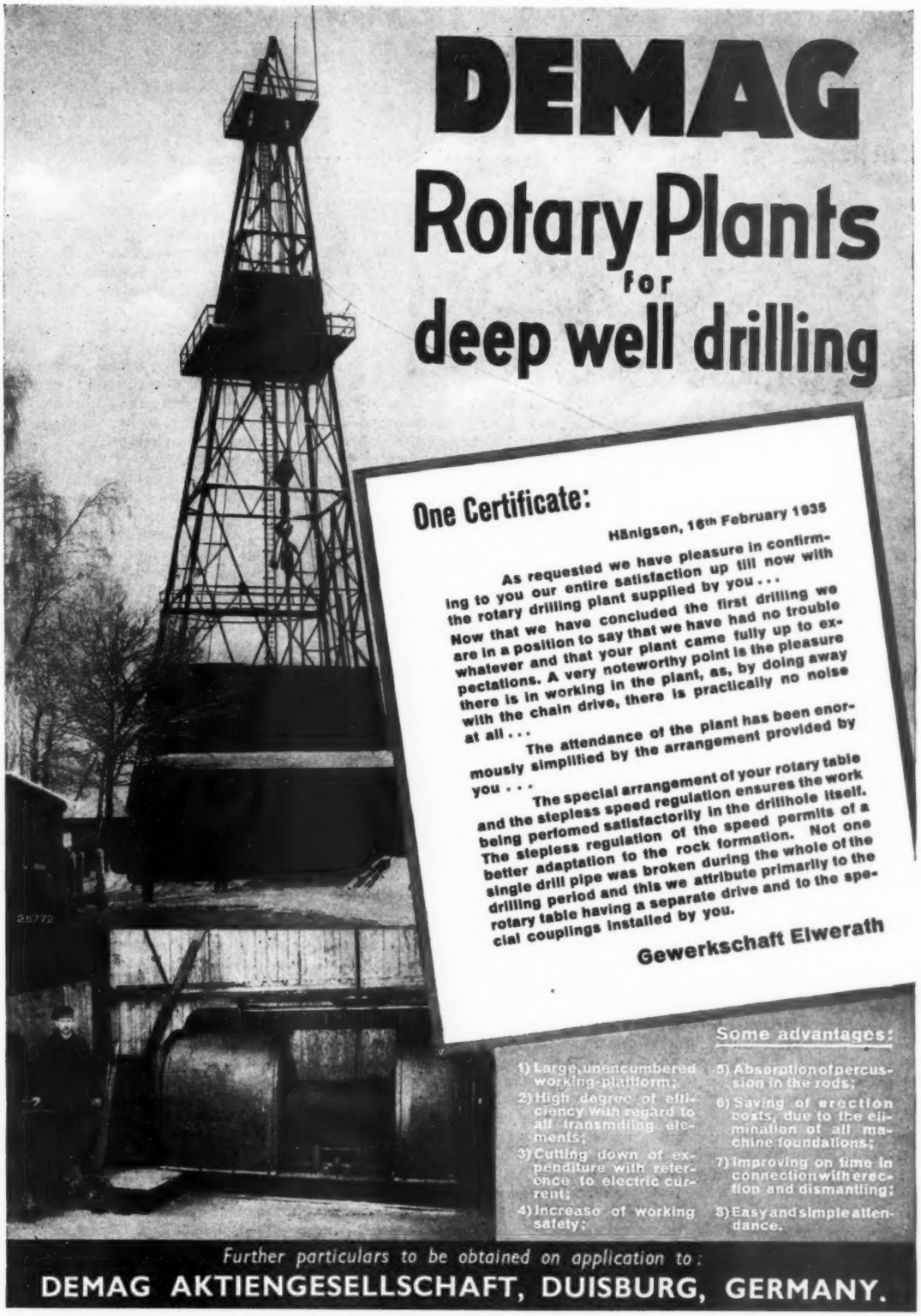
THE GASOLINE and crude oil futures market of the Commodity Exchange, which opened on March 5 of this year, has now been in existence a little over six months. Trading during this period, however, was far below expectations. Activity in gasoline futures has been disappointing, to say the least, while trading in crude oil contracts has been negligible. As a result, on August 29 several changes and additions were made in the by-laws and rules governing the buying and selling of contracts, in an effort more nearly to meet the requirements of the oil industry.

Chief among these were the rules eliminating the Federal Tax in all bids and offers in respect to gasoline contracts, and the elimination of New York as a delivery point. Henceforth all deliveries will be made in the Houston-Galveston area, Texas. Additions were also made in the specifications of tenderable grades of gasoline, consisting of a color test, which specifies that it shall not be darker than number 21 Saybolt "when tested by test method No. 10.11 of the United States Government Specifications," and the inclusion of a gum test which states that the gum content shall not exceed 10 milligrams of gum per 100 milliliters of gasoline.

Crude oil contracts were amended to eliminate the Cushing-Drumwright area, Oklahoma, as a delivery point; thus making the Houston-Galveston area the only delivery point for both gasoline and crude oil. Crude oils from certain counties in Texas and New Mexico have been eliminated as deliverable oils under the new contract, and the par A.P.I. gravity specifications of East Texas oils have been increased to 38 and up, as against 37 and up under the old contract.

Additional provisions, applying to both gasoline and crude oil, have been adopted with respect to payment of excess intra-state over inter-state freight rates and inspection fees, occupational tax and other taxes imposed by the state or any sub-division thereof on deliveries of gasoline; while other provisions state the tolerance in a delivery of gasoline or crude oil from licensed storage tank against Exchange Form of Receipt.

Inquiries concerning the gasoline and crude oil futures market of the Commodity Exchange should be addressed to Financial Editor, World Petroleum.



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SHIPPING

ATTENTION was drawn in WORLD PETROLEUM in a special article to the present state of Japan's tanker fleet. Local comment in Japan's WEEKLY CHRONICLE recently has drawn attention to the fact that Japan, while importing nearly 3,000,000 tons of oil per year, can only carry about one-third of it in vessels flying her own flag. She has 16 tankers, numbering about 183,000 tons, but several large, fast, twin screw units are building. Two ships are constructing for the Mutsui Bussan Co. and one for the Mitsubishi Co. The Japan Tanker Co. and the Yamashita Kisen Co. have recently placed orders for one tanker each, while five of 62,000 tons will be completed next year. The Japanese tanker situation is particularly interesting, since it has developed along entirely unorthodox lines. In all recent construction, they have not been content to follow contemporary practice of driving their ships of about 13½ knots sea speed loaded. It is more or less an open secret however, that the 16 and 17 knots loaded service speed at which Japanese designers aim is deliberately done in order to enable such vessels to keep up in some measure with a fleet at sea. Any individualistic tendency on the part of Japan to build sufficient tankers entirely to cover her own needs, would undoubtedly have quick repercussions in the world charter market which is already severely depressed and for which new construction now in hand will do little more than replace existing obsolescent vessels.

BOTH Standard New Jersey and Royal Dutch Shell Companies are active in their replacement programmes, while it is more than likely that the British Tanker Company, the marine branch of the Anglo Iranian Oil Company will be placing orders for one or more vessels in the near future. In the meantime, it is worth recalling that the Royal Dutch Shell group has again placed orders in Holland, the Netherland shipbuilding industry benefiting considerably thereby. The Netherland Co. at Amsterdam has received orders for a 4,000 ton steamer for special service in the West Indies, and a similar ship has been placed with the P. Smit Junr yard, and one small motor vessel of 550 tons has gone to the Van der Giessen Yard at Krimpen near Rotterdam. This little ship is intended for Portuguese service. The Royal Dutch Shell group has nine tankers under construction in Holland at the present time totaling about 70,000 tons, two being ships of 12,000 tons, four of 9,100 tons, the two 4,000 tonners mentioned above and one of 560 tons. It was rumoured in London recently that further new tonnage of large type is contemplated by the Royal Dutch Shell group but this rumour was afterwards denied.

THERE is much interest being shown now by tanker men in Dutch construction because the new tanker G. S. WALDEN recently ran successful trials on the Polperro mile near Plymouth. The G. S. WALDEN, it will be recalled was constructed at the yard of the Rotterdam Dry Dock and the trials are interesting inasmuch for the first time an opportunity was afforded for testing out the merits of hull design as applied to two sister ships, one built on normal lines and the other on Arcform. The sister ship of non-Arcform design was built in Germany and is named W. B. WALKER. Sea, tide and wind conditions for the two ships were almost identical and runs on the mile have produced the following figures; The normal form ship at 116 r.p.m. reached 12.46 knots mean and at 123½ r.p.m., 13.17 knots whereas the Arcform ship at 115 r.p.m. reached 12.83 knots and at 122 r.p.m., 13.5 knots. The net result of the trial is to the effect that the Arcform ship shows a gain of approximately half a knot over the speed attained by the normal form vessel. There is every appearance of truth in the suggestion that the Isherwood Arcform of tanker hull may have an effect upon the construction of these ships in the future similar to that which the ordinary Isherwood longitudinal and later the bracketless system had in the past, the difference being of course that the Arcform is a shape of hull whereas the others have been concerned with hull structure. Meanwhile two further tankers have been placed in U. S. yards with the Arcform hull.

COUNCIL of the International Tanker Owners Association has authorised a final payment of laid-up allowance to those members whose vessels were laid up during the second accounting period ended midnight May 3, 1935. This final payment at the rate of 6s.3d per gross register ton (Diesel basis) for the whole period (181 days) and pro rata for lesser periods. Interim distributions at the rate of 13s.6d have already been made, and the total distribution for the second accounting period therefore amounts to 19s.9d as compared with 15s.4½d for the first accounting period. The period covered by the payments which have now been made is 12 months.

INTERESTING details are available from a branch of the Fearnley Egers organisation, Oslo, concerning the amount of tanker tonnage laid up at the end of the June quarter. Tankers to the total of 940,693 tons come within this category, about two-thirds of which, i.e. 78 vessels of 652,036 tons consisting of steamers, the remainder being Diesel driven. The laid up ships include 41 of 332,538 tons in the clean class and 70 of 608,155 tons in the dirty class. Great Britain heads the list of laid up tonnage with 415,374 tons, mostly steamers; Norway is second with 230,653 tons, U. S. A. third with 177,849 tons and Italy fourth with 100,035 tons. Further analysis of the British figures shows 20 clean steamers of 160,004 tons, 18 dirty steamers of 166,185 tons, one clean motorship of 8,510 tons and nine dirty motor vessels of 80,675 tons. Similar analysis from Norway shows one clean steamer of 10,360 tons, eight dirty steamers of 75,740 tons, including one laid up for time charterers account, eight clean motorships of 84,422 tons and seven dirty motorships of 60,130 tons. Sweden has only two vessels laid up, both motor vessels, one clean and one dirty. The picture is not complete, however, as a visualisation of laid up tonnage for it must be remembered that although freights have not shown much sign of improvement a large number of ships laid up are obsolete for present requirements. This certainly applies to the steamers, the majority of which are quite incapable of competing commercially at present rates or indeed at rates likely to hold within the future as far as one can see.

AS REGARDS the state of construction at the present moment, the latest returns of Lloyd's REGISTER OF SHIPPING show that there is a total of 41 tank vessels now building throughout the world with a total gross of 328,026 tons. The prevalent popularity of the Diesel engine for propelling these vessels is well shown by the fact that there are 35 motorships of 284,825 tons gross as against only six steamers with 43,211 tons. Of these three are building in the U. S. A. with a total of 24,511 tons; Germany contributes two of 7,000 tons gross each and Holland one of 4,700 tons. These are vessels intended for carrying heavy oil on special routes. The greatest individual builder of motor tank vessels at the moment is Germany which has a total of seven units under construction of 71,000 tons. These are for Shell and for Standard interests. As far as the Scandinavian Companies are concerned it would appear as though at last a real check has been put upon the careless building of tramp tonnage. Sweden is building five units of 42,900 tons gross, Norway one of 6,582 tons and Denmark two of 18,800 tons. Many of these vessels are being constructed to take the place of old steamers whose charters are due to finish at about the time of completion of the motor vessels.

TANKER men in Europe are greatly interested in the turbine driven vessel SOCONY VACUUM which is regarded as a type having many possibilities for the special requirements of the American coastwise trade and also in districts where boiler oil is cheap. Propulsion is by means of a double reduction geared turbine set rated at 4,000 s.h.p. at 75 r.p.m. Machinery takes steam at 375 lbs. per square inch and 700 deg. F. total temperature, steam being supplied by three Foster Wheeler oil fired water tube boilers, which are arranged abaft and above the main shaft. This makes an extremely neat arrangement for it follows that the boiler will occupy space which if the more orthodox layout were used, would be completely wasted.

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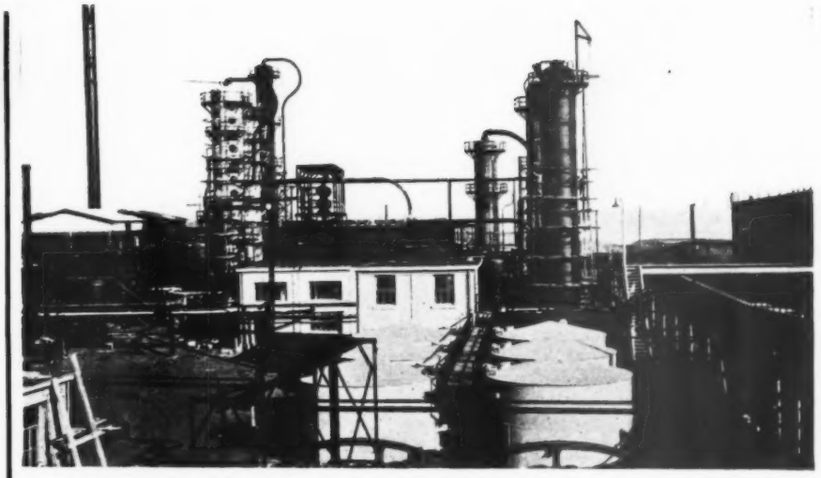
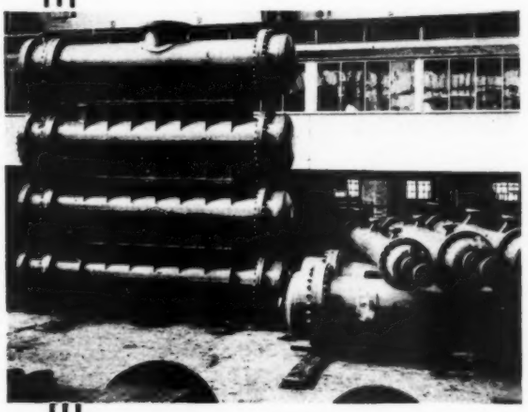


Pechelbronn-Ouest S.A. Refinery at Donges, Loire-Inf., FRANCE



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MEXICO

RECENT reductions in the price of gasoline at Mexico City are expected to have serious results. Producers contend that they are losing 1.8 centavos per liter. So far the producers have made no statement as to the action that they expect to take, but some statement is expected shortly. The present price of gasoline in Mexico City is equal to about 10½ cents per gallon in the United States compared with an average price in the United States on August 1, of 14.1 cents per gallon.

The low price prevailing in Mexico is partly the result of a short-sighted policy expressed by President Cardenas when he ordered the price reduced to 18 centavos (approximately 5 cents U. S.) per liter, including a tax of six centavos. The price is to be reduced still further to 17 centavos in January, 1936, when the government will reduce the tax one centavo. This attempt to fix prices at levels that prove uneconomic to producers and manufacturers, a situation that cannot long be maintained, is in opposition to the present administration's more enlightened policy as regards the petroleum industry in Mexico. In furtherance of this policy and as a means of stimulating production and exports of petroleum products, President Cardenas has ordered the oil production tax law amended to provide reduction to the following levels of imposts on output of these commodities:

Refined gasoline: two percent of its value; crude gasoline: four percent of worth of refined gasoline; refined kerosene: three percent of its value; crude kerosene: six percent of value of the refined product; lubricants: 2.50 pesos (3.60 pesos equal one American dollar) per cubic meter; paraffine: two pesos per metric ton; asphalts: half a peso per metric ton; asphaltic emulsions and solutions, containing up to 40 percent of distilled petroleum: half a peso per gross metric ton, and when these contain more than 40 percent of distilled petroleum the finance ministry will fix monthly tax quotas based upon the production of crude gasoline.

COMPAÑIA de Petroleos de Mexico, S. A. (Petromex, S. A.), the semi-official oil company, reports a net production of 172,195.19 bbl. from the 37 wells in federal reserves along the Panuco and Tamesi rivers, Lot 176 of the Amatlan zone and Lot 26 of the Zacamixtle zone, Vera Cruz state, that were given it by the now defunct Administrative Control of National Petroleum (a federal government agency) on Jan. 31 last, from Feb. 1 to June 30.

Net production comprised 129,741.33 bbl. of heavy crude obtained from Petromex's Panuco zone wells, and 42,453.86 bbl. of light crude, extracted from company's Tuxpan zone wells. Royalties of 21,083.79 and 2,234.41 bbl. of heavy and light crude, respectively, were awarded on these productions.

Petromex also announces that it has increased the daily handling capacity of its Tampico refinery to 1,800 bbl. from the 500 bbl. maximum it had last January. Plant is obtaining gasoline and other products from light crude produced in the Tuxpan zone. All products of the plant are in accord with standard specifications, which has increased sales of these commodities the report asserts. Petromex's board has approved plans for increasing the refinery's daily capacity to 4,500 bbl. and this work is to start soon.

WELL Carlos Cantú No. 2. recently brought in 37 kilometers from the Los Aldamas station of National Railways of Mexico's Monterrey-Matamoros division. Nuevo Leon state, near the American border, is producing an average of about 40,000 cu. mtrs. of natural gas daily, ministry of national economy announces. Gas was struck at a depth of 1,806 ft. The well's owners propose to supply several Nuevo Leon towns with gas.

Ministry of national economy has received complaints from Engineer Guillermo A. Alonso, Tampico manager for Compañia Mexicana de Petroleo COSMOS, S. A., that its petroleum department applies the oil laws in a "capricious fashion." Complaints say that the department sometimes approves private contracts and geologists' reports without investigation but rejects other similar matters even though such cases are both in order and verified; department often allows unreasonably short terms for the presentation of documents of proof, but at other times lets as many as seven years elapse before demanding these papers; and the department has sometimes rejected concessions applications even though these have been approved by the President of Mexico himself.

In connection with these complaints, the National Association of Petroleum Producers' volunteers to assist the ministry in drafting new regulations for the department so that it may function in a manner equitable to all concerned. The Association asks the ministry to permit it to revive several applications for oil concessions and drilling permits which it asserts the department turned down in an irregular manner.

MINISTRY of national economy announces expansion of the federal oil reserves in Vera Cruz state with the incorporation of parcel No. 194 of Talaxca y Arroyo Colorado tracts, Papantla zone, resulting from cancellation of the confirmatory concession held by a petroleum concern known as Manjak, S. A., and of several lots of the El Placer tract, Tuxpan sector, as a result of the rejection of an application to exploit them made by Ricardo Garcés.

DOUGLAS GRAHAME

CANADA

JUNE production in Alberta consisted of 100,331 bbl. of crude naphtha and 1,553 bbl. of light crude oil from the Turner Valley, 1,716 bbl. of light crude oil from the Red Coulee Field, and 1,583 bbl. of heavy crude oil from the Wainwright field.

Canada exported petroleum and its products to a value of $38,034 in June.

During May, 1935, Canada imported 7,090,856 gal. of natural casinghead gasoline valued at $358,084, and in June she imported 5,887,725 gal. valued at $333,831. Imports of gasoline lighter than .8235 specific gravity at 60 deg. temperature in May amounted to 1,256,328 gal. at $112,561; in June to 1,842,916 gal. at $166,828.

IN THE north end of Turner Valley field Moose No. 2 is drilling at 205 ft. and carrying 18 in. casing to make a second water shut off around 300 ft. Renfrew Royalties is drilling below 5,600 ft., and more gas and oil are being encountered.

At the Gem Dome Oil and Gas, Limited, on Le Grand Butte structure in southwestern Saskatchewan, the cellar has been dug and camp buildings erected.

In the Pekisko field, Pekisko Hills, wells re-

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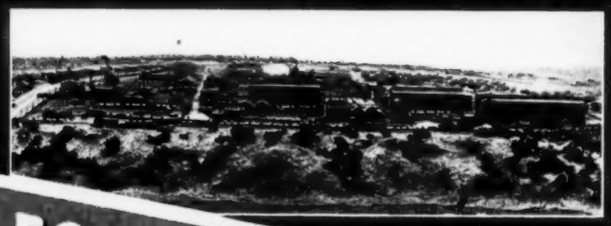

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cently encountered a showing of very dark green crude of 36 Baume gravity, the oil being in sufficient quantities to be brought up by the bailerful. At 3,020 ft. there was a change of formation which may have been the contact of the Banff shales.

Banner, in the same area, encountered gas at various horizons which, it is estimated, is in excess of 5,000,000 cu. ft. per day.

THE Standard Oil Company of California has started work on its refinery at Burnaby, B. C. This refinery will represent an initial investment of between $400,000 and $500,000. It will include distillation units charging 2,000 bbl. a day, and modern storage tanks, including the pontoon type floating roof tanks and an 80,000 bbl. storage tank. The Standard Oil Company of California will supply crude to the British Columbia company. A number of service stations will also be operated under the name of Standard Stations Limited.

MODEL Oils Limited, holder of 1,930 acres in the Turner Valley, will drill a well at Moose Drum when Model No. 3 in Turner Valley is completed, if conditions revealed at the Moose Oil well show favorable results. A report of this company shows that the net profit for the year ended May 31, 1935, was slightly lower than in the previous fiscal year, amounting to 2.8 cents per share as compared with four cents per share in the previous year. Working capital at the end of the fiscal year also shows a reduction, amounting to $99,553 as compared with $110,223 in the previous year.

CONSOLIDATED Oil Production, Inc. reports a total income of $60,549 from all sources for the year ended June 30th, 1935. Expenditures amounted to $9,806, leaving net profit of $50,742 before depletion and taxes. The balance sheet shows total assets of $640,086. Cash in bank amounts to $35,507 and investments $4,330, while current assets stand at $41,724. Current liabilities of $5,246 leave a working capital of $36,478. Fixed assets are shown at $572,081, reserves at $14,248, preferred shares issued and paid up $188,940, common $346,909, and capital surplus of $52,673.

ACME Refineries Ltd. are to erect a refinery on the old Iron Works premises at Deseronto.

CANADIAN Natural Gas Syndicate have drilled a new gas well at Eden, near Tillsonburg, Ont., with a capacity of 600,000 cubic feet per day.

WORK at the Renfrew Royalty is progressing satisfactorily: eight inch casing is being run to a depth of 5,540 ft. and preparation is being made for the run to the limestone, 300 ft.

THE Colony Oil and Gas Company's No. 1 well in the Lloydminster field showed a capacity of 50,000,000 cu. ft. of gas per day in a recent test, thus assuring its position as the largest gas well in Canada.

R. C. ROWE.

Gulf Export Prices for Major Oil Products

	Products	Cents per Gallon Aug. 22	Aug. 29	Sept. 5	Sept. 12
Gasoline:	U. S. Motor	4⅛	4⅛	4¾	4¾
	64/66–375 E. P.	5⅛	5	5	5
	59 Oct. & below	5¼	5¼	5¼	5¼
	65 Oct. & above	5½	5½	5½	5½
Aviation Gasoline:	73 Oct. & above	9½	9½	9½	9½
Kerosene:	44 w.w.	4¼	4¼	4¼	4¼
	41–43 w.w.	3⅞	3⅞	3⅞	3⅞
	41–43 p.w.	3⅞	3⅞	3⅞	3⅞
Gasoil:	26–30 translusc.	2⅞	3⅛	3⅛	3⅛
	30 plus translusc.	3⅛	3⅛	3⅛	3⅛
Fuel Oil:	Bunker purposes (per bbl.)	$ .90	$ .80	$ .80	$ .80
Grade C:	Cargo lots (per bbl.)	$ .70	$ .70	$ .70	$ .70
	Diesel oil (per bbl.)	$1.50	$1.50	$1.50	$1.50
Lubricating Oil:	Bright Stock No. 8	24	24	24	24
(New York Export	Bright Stock No. 6½	23½	23½	23½	23½
Market)	Warren E.	20	20	20	20
	600 Unfilt.	16½	16½	16½	16½
	650 Unfilt.	18	18	18	18
	600 Flash s.r.	18½	18½	19	19
	630 Flash s.r.	23	23	24	24
	Neutral 200 No. 3	28½	28½	28½	28½
	Neutral 150 No. 3½	23½	23½	23½	23½
Crude Oil:	East Texas crude delivered at Gulf port for Export	$1.17	$1.17	$1.17	$1.17½
	Venezuela crude	.83	.83	.83	.83
	Trinidad crude	.85	.85	.85	.85
	Panuco crude	.95	.95	.89	.87

▼

U. S. S. R.

1935	Crude Production (bbl.)	Daily Average (bbl.)	Run to Stills (bbl.)	Drilling (feet)
January	13,358,000	430,935	11,400,000	248,672
February	12,704,300	453,725	10,909,500	334,000
March	14,139,300	456,609	11,714,000	449,417
April	14,058,200	468,609	11,350,000	431,050
May	14,280,000	476,000	11,880,000	442,050
June	14,150,000	471,700	11,750,000	448,500
July	14,050,000	453,226	11,630,000	449,750
August	14,230,000	459,032	11,840,000	449,900
Total 8 Months 1935	110,969,800	456,667	92,473,500	3,253,439
Total 8 Months 1934	111,434,700	458,580	98,099,300	2,877,473
Total 8 Months 1933	104,267,500	429,085	98,937,580	1,741,445
Total 1934	168,648,700	458,042	145,141,000	4,122,898
Quota 1934	214,900,000	585,879	161,000,000	4,950,000
Quota 1935	212,310,000*	581,671	171,500,000	5,214,000

* Revised from 232,400,000 bbl. including gas
Except gas 198,800,000 bbl.

Crude conversion: Seven bbl. = one ton

AS A RESULT of recent decentralization of the management of the Azerbaidzan oil fields and their transformation into four separate producing units, activities were concentrated in individual places and the results have not failed to show up in crude production. At Ordzonikidzeneft (Baku) several idle wells which have required cleaning or repairs for some months have begun operation, resulting in increasing crude oil production in these fields from 12,000 bbl. to a total of 14,500 bbl. per day. Similar improvements at other Baku fields and wells at Maikop have improved the statistical position of production for the month; nevertheless the Soviet oil fields continue to operate behind plan, with the exception of Maikop, where on individual production per day this section exceeds the plan at the rate of five to eight percent.

Figures available for July operations at Baku show a total of 11,198,292 bbl. of crude produced during the month. This is 80.6 percent of the plan and exactly 3,101 bbl. of crude below the corresponding figure for June. For the first seven months of 1935 Baku fields have incurred arrears of 10,500,000 bbl. of crude, for which poor drilling and insufficient prospecting are reported to be responsible. During July, 27 wells were completed for operation at Stalinneft as against a quota of 66 wells; at Leninneft five new wells were started as against a quota of 10 wells, while nine wells were completed as against fifteen required. Similar deficiencies are reported from the other Baku fields and the Azerbaidzan Regional Communist Party together with M. Barinoff, head of Glavneft, have outlined a program of drilling activities according to which 274 drilling outfits should be operated at the beginning of August and 300 outfits at the end of the month. Breakdowns are still high at Baku oil fields. Ordzonikidzeneft has reported 52 breakdowns in

Exports of Petroleum Products from U. S. S R.

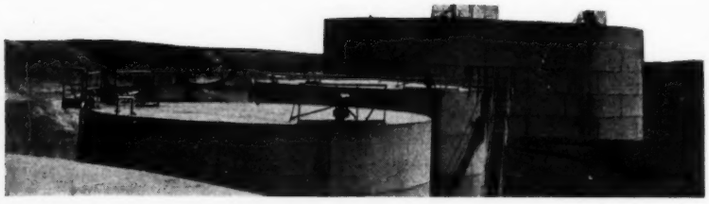
(Jan.-June 1935. Figures in Tons)

	Six Months Jan.-June 1935	1934	Percent increase or decrease
Crude	9,516	104,641	−90.9
Motor Spirit	365,683	660,282	−44.6
Kerosene	213,562	213,773	no change
Lubricating Oil (including Transformer Oil)	118,203	122,846	− 3.8
Fuel and Diesel	679,320	691,280	− 1.7
Gas Oil	236,789	317,795	−25.5
Asphalt	9,916	18,680	−46.9
Paraffin Wax	7,554	6,114	+23.6
Others	769	642	+19.8
Total	1,641,312	2,136,053	−23.2
Total Without Crude	1,631,796	2,031,412	−19.7

Exports of Oil Products from U. S. S. R. By Countries

(Six Months Jan.-June 1935-1934. In Tons)

	1935	1934	Percent increase or decrease
Afghanistan	1,240	1,234	+ 0.5
Belgium	53,474	88,412	− 39.5
British Empire	173,795	254,643	
Germany	217,114	239,319	− 9.3
Denmark	61,555	47,825	+ 28.7
Iran (Persia)	20,297	16,232	+ 25.0
Spain	116,045	261,405	− 55.6
Italy	129,696	354,143	− 63.4
East China	11,819	31,134	− 62.0
West China	541	285	+ 89.8
Latvia	4,392	762	+476.4
Lithuania	3,240	5,050	− 35.8
Mongolia	3,175	4,459	− 28.8
Norway	3,577	3,637	− 1.6
Tanu-Tuva	424	390	+ 8.7
Turkey	27,761	6,355	+336.8
South America	8,789	37,058	
Finland	8,355	10,633	− 21.4
France	176,730	400,438	− 55.9
Sweden	78,148	96,451	− 19.0
Esthonia	1,711	3,408	− 49.8
Japan	18,460	9,227	+100.1
All Other Countries	520,972	263,553	+ 97.7
Total	1,641,312	2,136,053	− 23.2



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OCECO FITTINGS

July, Stalinneft reported 41 and Leninneft 23.

M. Barinoff, head of Glavneft has emphasized the inefficiency in regard to prospecting, which has created a dangerous spread between demand and supply of crude oil. M. Barinoff has sounded a warning to all oil fields to prevent a reoccurrence of the catastrophe that befell Grozni, where production has dwindled from 56,448,000 bbl. in 1931 to 23,590,000 bbl. in 1934. The Grozni operators were warned in due time to take necessary precautions including: (1) Efficient organization of operations, (2) Concentration of prospecting at decisive regions, (3) Attention to deep drilling, (4) Reduction of cost of drilling, (5) Acceleration of drilling speed, (6) Improved geological service. In other words the warning has included all ills of Grozni which apparently have not yet been corrected. Operations during 1934 show that no improvement has taken place and a summary of prospecting operation over all Soviet new oil regions shows that of all new wells drilled during 1934, including all wells left over in 1933 for completion in 1934, exactly eight percent had to be abandoned owing to technical deficiencies which were followed by breakdowns. Further, 14 percent of all wells had to be abandoned owing to technical dangers involved. Exactly four percent of all new wells at regions under prospecting had to be abandoned as a result of geological mistakes made in the preliminary surveys. In addition to these a number of wells had to be abandoned as unfit for further operation. In other words about one-third of all wells drilled in 1934 had to be struck from the list of potential producers which were expected to replace exhausted wells or even to increase production. M. Barinoff further states that poor technique in deep drilling, breakdowns, stoppages and abandonment of a large number of exploratory wells together with deficient geology at preliminary surveys involve enormous losses and make drilling extremely costly. Millions have been spent in the Soviet Union on prospecting with no returns.

During 1935 prospecting operations were concentrated on completion of the following wells: Azerbaidzan—Pirsagat, Miadjik and Kiziltepe; Grozni—Achisu, Akhlovo, Alkhasovo, South Vosnesensk and Eldarovo; Vostokneft—Allaguvatovo and Kuspiakulovo; Maikop—the Kutais district; Kubcherneft—Keslerovo and Adagum; Middleasia—Haudag and Neftbad; Emba—Koschagil and South Iskin; Turcomanneft—the southern wing of Neftdag. At Koschagil (Emba), a well came in flowing initially 3,000 bbl. per day after drilling 1,500 ft. The Koschagil field already has 13 operating wells, some of which have a potential crude capacity of about 7,000 bbl. per day and four more wells are drilling. All flowing wells, however, were shut in on account of lack of transportation until completion of the pipeline. A well flowing about 14,000 bbl. of crude during the first 30 hours of operation has come in at Ishimbayevo. This was followed by some other small wells located on the right flank of the formation. Usual production of wells at Ishimbayevo does not exceed 800 to 1,200 bbl. of crude per well per day.

An example of the inefficiency that characterizes current operations in Soviet fields is

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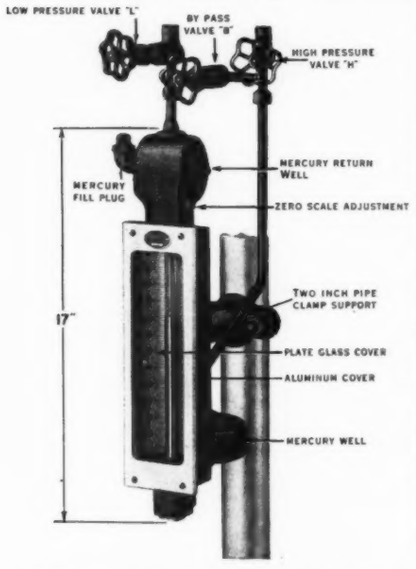

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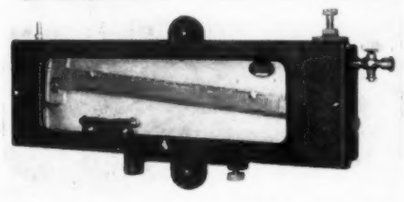

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found at Baku. Gas trapping is a rare practice in Soviet oil fields, and it is estimated that at Baku alone the losses incurred from the lack of this practice exceed 60,000 tons of natural gasoline each year.

THE ALCO installations at Grozni have for the past three years produced a by-product classified as "cylinder stock" (over 200,000 tons per year) which under the present conditions is used as boiler fuel, while under American practice this by-product could yield about 5,000 tons of aviation lubeoil, 6,000 tons of paraffin 75-78 degrees C. melting point and about 40,000 tons of technical vaseline. At many cracking installations all heavy odds and ends are used as boiler fuel, while secondary rerun of the same would produce a high grade kerosene. At Grozni these ends under rerun would yield from 35,000 to 45,000 tons of illuminating kerosene.

IN a recent editorial in ZA INDUSTRIALIZATIU of July 2nd 1935, G. Lomoff, for several years past connected with the Soviet oil industry as chairman of the Board of Directors, has commented on various phases of the oil industry as follows:

> The ever growing demand for gasoline, ligroin and other products to supply the increasing number of motor vehicles, tractors and combines in use in the Soviet Union, has created a spread between demand and supply which is growing into something very serious. Crude production for the first seven months of 1935 has remained practically unchanged from the corresponding period last year, while production of gasoline and kerosene have increased 8.5 and 3.0 percent respectively. The actual increases attained from major oil products as compared with the increases attained in production of other industrial branches of Soviet Heavy Industries are almost negligible. While pig iron production has increased 25 percent, steel 31 percent, the production of motor cars, 34 percent, gasoline production was increased only 8.5 percent.
>
> The Soviet oil industry has unlimited possibilities to do at least as well as other industrial branches, but this requires more attention and more advanced methods of operation along the lines practiced in the United States and elsewhere. Generally it looks as if the Soviet oil industry is content to be considered the main source for fuel oil and heavy lubricants and, therefore, neither Baku, Grozni, Maikop or any of the other Soviet oil fields are interested in all the volatile ingredients contained in crude oil or in the chemical composition of the same. At Lokbatan, Kala and other fields of Baku the oil wells are exposed to atmospheric influences and the oil from wells is transported to storage or refineries in open ditches. Protection against evaporation at wells and en route at Baku and elsewhere is still a matter of discussion and the necessary measures for action in this direction have not materialized as yet.

Kala crude contains about six percent of gasoline when leaving the well but under the present system of transportation to Grozni for refining the volatile components evaporate. The quantities of crude required for shipment

PREVENT BLOWOUTS WITH SHAFFER HIGH PRESSURE DRILLING HOOKUPS

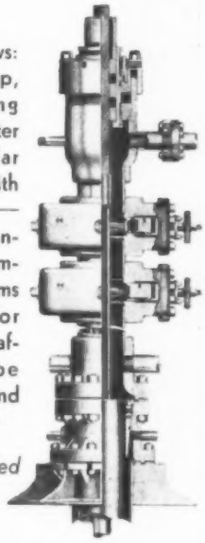

Illustration shows: beginning at top, Shaffer Rotating Blowout Preventer — Shaffer Cellar Control Gate with drill pipe rams — Shaffer Cellar Control Gate with complete shut-off rams — Mudcross for circulation — Shaffer Spool Type Landing Head and Landing Base —

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from Baku to Grozni in 1935 carry a loss of over 160,000 tons of gasoline. Lokbatan crude containing about five percent of gasoline is being shipped to Batum for refining, but over 50 percent of the volatile contents are being lost under the prevailing methods of transportation. Hundreds of thousands of tons of gasoline which represent a high grade aviation fuel are being lost each year in transportation. The crude from Stalin oil fields of Baku contains not less than 21 percent of gasoline, but almost 400,000 tons of this gasoline are being wasted each year in transportation. According to an official estimate 200,000 tons of gasoline were wasted during the first five months of 1935 at Baku in transportation from the fields to the refineries, while the total gasoline produced by straight run at Baku during the same period amounted to 316,000 tons. Grozni, Maikop and other Soviet oil fields produce crude grades which contain high percentages of gasoline, but as no check of the waste has ever been made, no estimates are possible.

Baku crude has to be shipped to Grozni in order to keep the refineries on stream since Grozni oil fields are at present unable to take care of the needs of its refineries; the carrying of Baku crude to Grozni has thus become an unavoidable necessity. It is rather strange, however, that the Baku refineries are supplied first and foremost, while Grozni can get only what is left over at Baku. Most of the shell stills at Baku are approaching obsolescence; some of them were erected 60 years ago and their yield, when charged at full capacity does not exceed 17 percent of light products from the potential of the crude, which is about 39 percent, i.e. about 50 percent of the potential, while the refineries of Grozni and Tuapse are of more modern design and construction and yield 80 percent of light products from the potential of the crude. Grozni refineries operate at present much below capacity; the Tuapse refineries operate only about 60 percent of their actual charging capacity. Arrears in supply of Baku crude to Grozni vary from 50 percent of the quantities required in January, 20 percent in March to 16 percent during subsequent months. Grozni refineries were designed and constructed for deeper cuts from the input than the refineries of Baku but as yet no advantage has been taken of this fact.

The high rate of losses incurred at the refineries of Grozni are due to leaking pipelines and to negligence at the tank farms. Makhatch Kala refining capacity is about 70,000 tons per month and the high rate of losses is due to lack of pressure in the pipelines. Negligence in service is responsible for losses at Makhatch Kala arising from uninterrupted transportation of refined products through lines which were broken at a distance of about 20 meters (66 ft.) from the refinery terminal, an accident which remained undiscovered for some time owing to lack of manometers or other pressure measuring instruments.

Plan fulfillment of the major Soviet oil fields is at present as follows: Azerbaidzan, 81–83 percent of plan; Grozni, 86–88 percent of plan; and Maikop, 95–106 percent of plan.

J. WEGRIN

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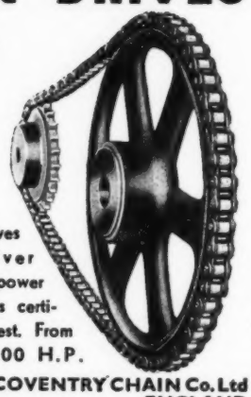

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